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Soil Survey

Sullivan County New York

By
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United States Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS provide a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) Those interested in the area as a whole; (2) farmers and others interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) County Surveyed, in which location and extent; physiography, relief, and drainage; climate; vegetation; history and organization; population; industries; transportation and markets; and cultural development and improvement are discussed; (2) Agriculture, in which a brief history and the present status of the agriculture are described; (3) Productivity Ratings in which the productivity of the soils is given and a grouping of soils according to their relative physical suitability for agricultural use are presented; (4) Land Uses and Agricultural Methods, in which the present use of the soils are described, their management requirements are discussed, and suggestions made for improvement; and (5) Erosion, in which the problems pertaining to the control of accelerated erosion are treated.

Readers interested chiefly in specific areas—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils and Crops the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Productivity Ratings, Generalized Land-Use Suitability Map, Land Uses and Agricultural Methods, and Erosion.

Students and teachers of soil science and allied subjects—including crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils and Crops, in which are presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on County Surveyed, Agriculture, Productivity Ratings, and the first part of the section on Soils and Crops of particular value in determining the relations between their special subjects and the soils of the area. Soil scientists and students of soils will find special interest in the section on Morphology and Genesis of Soils.

This publication on the soil survey of Sullivan County, N. Y., is a cooperative contribution from the—

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SOIL SURVEY OF SULLIVAN COUNTY, NEW YORK

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Area inspected by JAMES THORP, Principal Soil Scientist, Division of Soil Survey

United States Department of Agriculture in cooperation with the Cornell University Agricultural Experiment Station

CONTENTS

AGRICULTURE began in the area that is now Sullivan County about 1700, when the first permanent settlers located in Mamakating Hollow. These pioneers were isolated from the more populous centers by mountains and by the lack of roads and navigable streams. The building of a turnpike in 1808 opened the county to the outside markets and encouraged immigration. At first farming was mostly on a subsistence basis. Corn, oats, rye, wheat, buckwheat, and potatoes

[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

were the leading crops, and livestock raising and the production of maple sugar were important. With the opening of the Delaware & Hudson Canal in 1828 an easy and cheap avenue to the market was opened. Lumbering, tanning, and gristmill operations soon expanded rapidly. The original forest was cleared or cut over at an early date, and wherever sufficient water was available, sawmills and gristmills sprang up. With the development of transportation, lumber mills and tanneries were built everywhere and represented the most important early industries of the county. Today lumbering is a minor industry, although more than half the county remains in forest, consisting of second growth and forest plantations. Dairying is the most important single enterprise. The chief crops, other than those required for dairies, are potatoes, buckwheat, and vegetables. Other industries include a plant manufacturing charcoal, wood alcohol, and acetate of lime, a furniture factory, a last-block and bowling-pin factory, and a creosote plant for treating railroad ties. To provide a basis for the best agricultural uses of the land a cooperative soil survey was begun in 1938 by the United States Department of Agriculture and the Cornell University Agricultural Experiment Station. The essential features may be summarized as follows:

SUMMARY

Sullivan County covers an area of 986 square miles in the southeastern part of New York State in the foothills of the Catskill Mountains. The county lies within the northeastern extension of the Appalachian Plateaus and comprises a deeply dissected plateau that slopes gently to the south and southwest. The deep valleys are comparatively narrow, but in a few places are a mile wide or more.

The flanks of the divides, wherever steep or broken, are wooded, as is much of the more mountainous uplands. Many natural and artificial lakes dot the landscape. Because of its scenic splendor, this county has long been a haven for summer vacationists.

The less rugged parts of the uplands and most of the valleys are used for farming. In comparison with the grassland, the total acreage in crops is patchy and scattered, owing to the fact that on most of the farms the cropping system and general plan of management centers on the production of milk. Although poultry raising is important, very little grain is grown locally in support of it.

On most of the farms sufficient hay and silage are produced to feed the stock in winter, but occasionally a little hay is bought outside. Most of the concentrated feeds consumed come from outside sources.

The original agriculture of the county was more diversified and of the self-sufficient type during early settlement. Under those conditions much more of the land topographically tillable was occupied and the population was more widely distributed. Competition from the Western States in the production of grain and livestock and increased demands for dairy and poultry products led to the present type of farming in this part of the State. The change to a more specialized type of agriculture has caused farming to become concentrated in the central and west-central parts of the county, especially in the areas of red soils. Most of the abandoned farms were situated on the Culvers and associated soils.

The soils, climatic conditions, and geographic location of the county are highly favorable to the present type of agriculture. The average frost-free season is 147 days in length at Liberty and 133 days at Jeffersonville. The winters are long, and the summers are cool. Precipitation is rather well distributed throughout the year.

The concentration of agriculture in the areas of red soils is very noticeable. The well-drained soils developed from red shale and sandstone drift in general are the most productive and are adapted to most of the crops commonly grown. Barbour silt loam, Walton silt loam, and Walton gravelly loam are excellent soils for crops, but the Barbour soil is not very extensive. Lackawanna silt loam, Barbour fine sandy loam, Barbour gravelly loam, and Tunkhannock gravelly loam are good to excellent soils for crops. On these soils and on the imperfectly drained Wellsboro silt loam most of the agriculture is carried on.

The well-drained soils developed from gray sandstones and Hudson shales are in general fair to good agriculturally. Of these, Dutchess silt loam, Troy gravelly loam, Catskill silt loam, Catskill loam, Liberty sandy loam, and Chenango gravelly loam are good. Culvers loam, Culvers silt loam, Wurtsboro sandy loam, Pittstown silt loam, Catskill sandy loam, and Chenango gravelly sandy loam are only fair. The Culvers soils in many respects are even better suited to pasture than to cropland.

The following are only fair soils for crops: Lackawanna silt loam, shallow phase; Barbour loamy sand; Barbour gravelly loam, alluvial-fan phase; Tunkhannock gravelly loam, alluvial-fan phase; Tunkhannock loamy sand; Colchester loamy sand; Colchester gravelly loam; Otisville gravelly sandy loam; and Otisville gravelly loam. Their value is limited usually by some particular characteristic, such as shallowness, porosity, or strong relief.

A large part of the land pastured is plowable, and a large part of that plowable represents arable soils of the Wellsboro and Culvers series, although arable areas of the better drained soils are also pastured. Nearly 40 percent of the pasture land, however, is not plowable, because of stoniness, unfavorable drainage conditions, or strong relief. Many stony soils are pastured because on many of the farms insufficient arable land is available for pasture. Stony areas of the better drained soils, as well as areas of the imperfectly and poorly drained soils, are pastured. A large part of the pastures are woodland pastures. In recent years there has been a trend toward pasture improvement, not only in the use of lime and phosphates but also in the use of better soils for this purpose.

The chief crops, other than those required for dairies, are potatoes, buckwheat, and vegetables. The total acreage of these crops, however, is small as compared with that in other counties.

Most of the stony soils are best suited to forest because they are too steep or stony for any other purpose. Most of the other soils would produce better forests than the forest soils, but they can be used more advantageously for crops or pasture.

The great soil groups represented are the Brown Podzolic, Podzol, and the Gray-Brown Podzolic soils. The best Podzol development is on the somewhat flattened ridge tops and on lighter materials of outwash terraces. Much evidence of Podzol profiles has been destroyed

on land under sod and where the forests have been cut over in recent years.

COUNTY SURVEYED

LOCATION AND EXTENT

Sullivan County is in the southeastern part of the State of New York (fig. 1). The eastern boundary is about 25 miles west of the

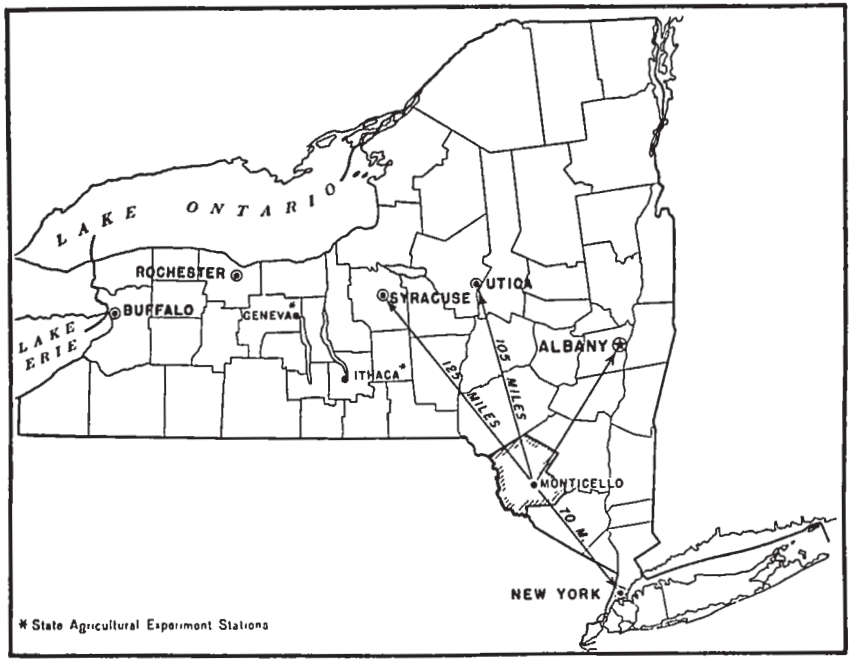

FIGURE 1.—Location of Sullivan County in New York.

Hudson River, and the southern boundary is 60 miles northwest of New York City. The Delaware River flows in a meandering course along the western and southwestern edge of the county and forms a part of the Pennsylvania-New York State line. Monticello, the county seat, is 70 miles by air line northwest of New York City, and 41 miles northwest of Newburgh on the Hudson. The county is irregular to roughly rectangular in outline. The average east-west dimension is about 29 miles, and the average north-south dimension is 35 miles. The total land area is 986 square miles, or 631,040 acres.

PHYSIOGRAPHY RELIEF, AND DRAINAGE

The county lies mainly within the Catskill section (*11*)[2] of the northeastern extension of the Appalachian Plateaus physical province of the United States (*2*). The region of which Sullivan County is a part is a deeply dissected plateau that slopes gently to the south

[2]Figures in parentheses refer to Literature Cited, p. 98.

and southwest. Before dissection this area constituted a smooth southwestward-sloping plain or plateau. The present mountainous relief is due to geologic erosion and deep dissection of the elevated mass by the action of numerous streams. These mountains may be called erosion mountains. All the rocks of the Catskills are of Devonian age, and they consist almost entirely of sandstones and conglomerates. The Shawangunk Mountains, which cross the southeastern corner of the county, differ considerably from those of the Catskill Plateau. These mountains are the products of folding at the time of the Appalachian revolution. They are sometimes spoken of as the "little mountains east of the Catskills" (*9*). As a result of folding and subsequent erosion, the great sheet of hard and resistant conglomerate has been left as a protective cap over most of the soft rocks, referred to as the Hudson River shales. The rocks of the Shawangunk Mountains—conglomerate and shales—are of Silurian and Ordovician ages.

The maximum relief of the county is over 2,650 feet. Denman Mountain, in the northeastern part of the county, is the highest point, having an altitude of 3,051 feet. The lowest point, east of Burlingham at the junction of the Shawangunk Kill and Platte Kill, is somewhat less than 380 feet. In the northern and northeastern part of the county the relief is steeply sloping, including here and there a somewhat flattened ridge. Elevations of the higher points in this area are considerably higher than those in the central and southern parts of the county. Blue Hill, having an elevation of 2,755 feet, Rattle Hill, having an elevation of 2,560 feet, and Denman Mountain, all in this area, consist mainly of watershed ridges. They constitute the part of the Catskill Forest Preserve that lies in Sullivan County. The tops of most of these higher areas are capped with a hard sandstone conglomerate, which may account in part for their higher elevations, as this rock resists erosion.

The relief of the central and southern parts of the county is less rugged and assumes more the character of a rolling plateau. Slopes are more gentle, and many of the ridge tops are smooth to gently rolling. The steepest slopes in this area are found along the valley walls of major streams dissecting the area. Average elevations of the plateau ridges range from about 1,500 feet in the north-central to 1,200 feet in the southwestern part of the county.

The Shawangunk Mountains are uniform in outline, and they slope steeply to the northwest and southeast. The highest point, 1,800 feet above sea level, occurs at the Sullivan-Ulster County line northeast of Phillipsport. Along the eastern foothills of this range the relief is somewhat rolling, characteristic of morainic country.

Most of the valleys are narrow; the river flood plains in few places are as much as half a mile in width, and in many places along the larger streams they are less than a quarter of a mile. The valley walls rise steeply to the plateau level; many of them form deep gorges along the streams. The valley of the Basher Kill is the widest, being approximately 1 mile in width at Haven, which is southwest of Wurtsboro. The smaller streams have very narrow valleys, which, as they approach the major streams, generally are V-shaped. Near their source the irregular valleys of these small streams contain many lakes, filled-in lake basins, and low mucky and swampy bottoms. At the

headwaters of the small streams west of the Mongaup River there are many swamps and bogs.

Throughout the county numerous natural lakes are picturesque features of the landscape. In addition, many small artificial ponds and a few reservoirs have been constructed. Three large artificial lakes have been constructed along the Mongaup River as a source of power. Lords, McKee, Wolf, and Yankee Reservoirs and Beaverdam Pond were built a long time ago as control feeders for the now abandoned Delaware & Hudson Canal. Hodge Pond, lying in the northeastern part of the county at an elevation of 2,620 feet, is the highest lake in the county. The elevations of the more important resort center lakes are as follows: Tennanah Lake, 1,956 feet; Yankee Reservoir, 1,434 feet; Swan Lake, 1,334 feet; White Lake, 1,325 feet; and Lake Huntington, 1,201 feet.

The many lakes, trout streams, and forests, together with the cool summers, make this county an ideal recreational center where many city dwellers spend vacations and week ends at the numerous hotels, boarding houses, and summer camps. Several camps for children are occupied during July and August. The largest of these camps is maintained by the Boy Scout organizations of New York City in the vicinity of Tylertown and Crystal Lake, which are southwest of White Lake. Many of the streams and lakes are stocked with fish from State and private hatcheries. The large areas of unimproved land and the Catskill Forest Preserve areas furnish excellent cover for small and large game. Squirrels, rabbits, and deer are plentiful.

With the exception of a small district on its eastern border, all the county is drained by the Delaware River and its tributaries. The small streams from the western and southwestern parts flow directly into this river. Willowemoc Creek drains the north-central part and flows northwestward into Delaware County, where it joins the East Branch of Beaver Kill and eventually empties into the Delaware River. The Mongaup River, rising in the vicinity of Liberty village and White Sulphur Springs, flows almost due south through the central part and joins the Delaware River at Mongaup. The Neversink River, rising in Ulster County, enters the county from the northeast, flows southward, and joins the Delaware River at Port Jervis in Orange County. Basher Kill, the principal tributary of the Neversink River, rises near Summitville and flows southwestward into Orange County, thus draining a fairly large area of southeastern Sullivan County. The Neversink and Mongaup Rivers drain respectively the eastern and central parts and are the two largest tributaries of the Delaware River from this county. Rondout and Sandburg Creeks and Shawangunk Kill, which drain about one-tenth of the area of Sullivan County in eastern and southeastern parts, flow eventually into the Hudson River. For the purpose of obtaining part of its water supply, the city of New York is now (1938) constructing a reservoir in the valley of Rondout Creek mainly in Ulster County. The northwestern end of this reservoir will extend well into Sullivan County. A similar reservoir is proposed for the Neversink River, to be constructed near Neversink.[8]

[8] Sullivan County is divided into 15 towns, as follows: Bethel, Callicoon, Cochecton, Delaware, Fallsburgh, Forestburg, Fremont, Highland, Liberty, Lumberland, Mamakating, Neversink, Rockland, Thompson, and Tusten. For brevity, hereafter these towns will be referred to merely by one name, as Bethel. Villages and communities by the same names will be specifically referred to, as "Liberty village" or "Callicoon community," where necessary to avoid confusion.

CLIMATE

Sullivan County has a continental climate, characterized by long, rather severe winters and comparatively cool summers. Although the summers include some very hot days, the elevation and the comparatively dry atmosphere combine to give high day temperatures, and the nights are decidedly cool, owing to the rapid loss of heat by radiation. During the summer the mean average temperature is about 65° F., although maximums of 99° are not uncommon. Winter begins early and continues severe throughout the season. The lowest temperature ever recorded in the county was −34°. The mean average temperature for the winter is between 22° and 24°.

There are two United States Weather Bureau stations in the county. One is at Jeffersonville, at an elevation of 1,080 feet; the other is at Liberty, at an elevation of 2,000 feet. The Jeffersonville station is in the valley of Callicoon Creek, and its records are more representative of areas in the valleys. The Liberty station is at a higher elevation, and its records are more representative of the Catskill Plateau. Although the mean annual temperatures for the two stations are not very different, the average length of growing season is about 14 days shorter in the valleys than on the plateau proper. Climatic conditions in the southern part of the county vary somewhat from those of the plateau area. In the vicinity of Wurtsboro and Bloomingburg the average length of growing season is from 1 to 2 weeks longer than that at Liberty.

The mean annual temperature recorded at Jeffersonville is 45.7° F. The difference between the mean summer and the mean winter temperature is 41.7°. The average date of the last killing frost at Jeffersonville is May 19, and of the earliest, September 29, giving an average frost-free season of 133 days. At Liberty this season is 147 days long. Frost has been recorded at the Jeffersonville station as late as June 20 and as early as August 25, and at the Liberty station as late as June 5 and as early as September 14. For most crops a safe growing season is somewhat longer than 120 days.

The mean annual precipitation of 41.51 inches at Jeffersonville and 45.03 inches at Liberty is well distributed throughout the year. The heaviest precipitation occurs during the growing season when most needed by the growing crops. The average annual snowfall is 48.4 inches at Jeffersonville and 53 inches at Liberty. Occasionally rainfall is abnormal or deficient, although practically neither condition is sufficient to cause crop failure in the county as a whole. In 1856, the driest year on record in the county at the Liberty station, the annual precipitation was 33.68 inches. Although the precipitation during the summer was only 1.64 inches below normal, crops no doubt suffered some, as precipitation was about 3 inches below normal in July, the hottest month. In 1857, the wettest year on record at the Liberty station, the annual precipitation was 55.46 inches.

Planting on the imperfectly drained soils is generally delayed because of heavy spring rains and lack of adequate tiling or ditching. When the soil water changes from liquid to vapor on evaporation, much heat is drawn from the soil, thus keeping it cold.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Jeffersonville, Sullivan County, N. Y.*

[Elevation, 1,080 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1930)	Total for the wettest year (1927)	Average snowfall
	°F	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	26 4	68	−27	3 02	2 00	5 07	10. 1
January	23 4	69	−34	2 84	2 27	3. 24	11. 8
February	22 5	66	−29	2 96	2 78	3 72	13 3
Winter	24 1	69	−34	8 82	7 05	12 03	35 2
March	32 7	82	−15	3 06	3 29	2 19	8 2
April	44 6	91	6	3 20	1 81	2 31	1 6
May	55. 4	96	20	3 24	3 02	4 02	(1)
Spring	44 2	96	−15	9 50	8 12	9 42	9 8
June	63 5	98	29	3 70	4 04	4 40	0
July	67 9	99	35	4 64	2 85	5 13	0
August	66 0	99	30	4 62	3 07	6 07	0
Summer	65 8	99	29	13 05	9 96	15 60	0
September	59 9	92	23	3 66	4 61	3 33	0
October	49 1	90	7	3. 50	2 40	8 69	.4
November	37 4	78	−7	2 98	1 64	5 60	3 0
Fall	48 8	92	−7	10 14	8 65	17 62	3 4
Year	45 7	99	−34	41 51	33 78	54 67	48 4

[1] Trace.

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at Liberty, Sullivan County, N. Y.*

[Elevation, 2,000 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1856)	Total for the wettest year (1857)	Average snowfall
	°F	°F.	°F	*Inches*	*Inches*	*Inches*	*Inches*
December	24 0	64	−20	3 53	4. 52	4. 32	10 8
January	22 0	62	−16	3 02	1 45	3 60	10 7
February	20 5	56	−18	3 05	1 22	2 24	12. 6
Winter	22 2	64	−20	9 60	7 19	10 16	34 1
March	30 0	78	−7	3 30	1 87	3 38	12 4
April	41 7	85	7	3 98	2 40	8 76	1 2
May	54 5	89	21	3 83	4 48	7 17	(1)
Spring	42 1	89	−7	11 11	8 75	19 31	13 6
June	62 6	90	26	4 83	3 63	5 55	.0
July	67. 6	95	39	4 47	1 50	7. 10	.0
August	65 2	95	38	4 36	6 89	4 34	.0
Summer	65 1	95	26	13 66	12 02	16 99	0
September	58 1	87	23	3 91	1 92	2 94	.0
October	47. 5	84	20	3 48	.91	3 76	.4
November	35 5	72	0	3 27	2 89	2. 30	4 9
Fall	47 0	87	0	10 66	5. 72	9 00	5 3
Year	44 1	95	−20	45 03	33 68	55 46	53 0

[1] Trace.

The prevailing winds of the county are from the northwest or west throughout the year. Tornadoes or destructive winds are rare. The percentage of sunshine possible during the growing season ranges from 56 percent in the northwestern part of the county to 60 percent in the southern part. The percentage of sunshine is somewhat higher during the summer than during the winter. This is a distinct benefit to the agricultural activities.

Tables 1 and 2 give the more important climatic data for Sullivan County as recorded by the United States Weather Bureau stations at Jeffersonville and Liberty. Other information may be secured from Cornell University Agricultural Experiment Station Bulletin 444 (*10*).

VEGETATION

Originally this general region was heavily forested with mixed hardwoods and conifers, except that there were a few grass-covered swamps. Hemlock was abundant throughout the county, and in 1855 about 40 tanneries in the county were using tanbark and producing over 2 million dollars' worth of leather annually (*3*). The area covered by Sullivan County lies in three forest zones: Zone B follows the valleys of the Delaware and its tributaries and the Shawangunk Mountains; zone D very closely follows the more rugged mountainous areas now included in the Catskill Forest Preserve; and the intermediate zone C lies south of the higher mountains and on the plateau above the valleys (*1*). Zone B occupies elevations ranging from low to about 1,200 feet in the principal valleys of the county. In the southern part of the county where the growing season is somewhat longer, especially in the town of Mamakating and on southern exposed slopes, it reaches to somewhat higher elevations; zone C, the Alleghany-Transition forest zone, covers the greatest area and occurs at elevations of about 1,200 to 2,000 feet; and zone D, the Canadian-Transition zone, covers a small area of the northern part of the county at elevations of 2,000 feet or more. In zone B, oaks, hickories, chestnut, and tuliptree predominate; in zone C, sugar maple, beech, yellow birch, hemlock, and white pine; and in zone D, the trees that predominate in C and in addition in certain situations, especially at the higher elevations, red spruce, balsam, paper birch, and mountain-ash. Zone D is further characterized by absence of oak, hickories, and elms; that is, species dominant in zone B. Where the soil conditions are favorable, forests typical of one zone may develop in an adjacent zone; that is, forests of zone B or D may develop in zone C, but never those of zone B in zone D, or vice versa, in this county.

The following trees are the key indicators in zone B: Redcedar (*Juniperus virginiana* L.), black walnut (*Juglans nigra* L.), butternut (*J. cinerea* L.), shagbark or shellbark hickory (*Carya ovata* (Mill.) K. Koch), mockernut hickory (*C. tomentosa* (Lam.) Nutt.), pignut hickory (*C. glabra* (Mill.) Sweet), sweet birch or black birch (*Betula lenta* L.), red oak (*Quercus rubra* L.), pin oak (*Q. palustris* Muench.), scarlet oak (*Q. coccinea* Muench.), chestnut (*Castanea dentata* (Marsh) Borkh.), bear oak (*Q. ilicifolia Weng.*), black oak (*Q. velutina* Lam.), white oak (*Q. alba* L.), chestnut or rock oak (*Q. prinus* L.), chinquapin or yellow oak (*Q. muehlenbergii* Engelm.), cucumbertree (*Magnolia acuminata* L.), tuliptree (*Liriodendron tulip-*

ifera L.), sassafras (*Sassafras albidum* (Nutt.) Nees), American sycamore (*Platanus occidentalis* L.), flowering dogwood (*Cornus florida* L.), rosebay rhododendron (*Rhododendron maximum* L.), and mountain-laurel (*Kalmia latifolia* L.). The herbaceous growth associated with this forest includes white dogtooth violet, lizardtail, goldenseal, partridgeberry, wintergreen, American cowslip, bluebells, and smilax.

In zone C, the Alleghany-Transition forest zone, the following trees are the key indicator species: Eastern white pine (*Pinus strobus* L.), eastern hemlock (*Tsuga canadensis* L. Carr.), eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch), American hornbeam, blue beech, or water beech (*Carpinus caroliniana* (Walt.), yellow birch (*Betula lutea* Michx.), American beech (*Fagus grandifolia* Ehrh.), witch-hazel (*Hamamelis virginiana* L.), black cherry (*Prunus virginiana* L.), downy serviceberry or shadbush (*Amelanchier canadensis* (L.) Med.), sugar maple (*Acer saccharum* K. Koch), red maple (*A. rubrum* L.), striped maple (*A. pennsylvanicum* L.), mountain maple (*A. spicatum* Lam.), American basswood or linden (*Tilia americana* L.), and white ash (*Fraxinus americana* L.). The undergrowth here includes fern, jack-in-the-pulpit, wild leek, yellow adderstongue, Solomonseal, Indian cucumber, trillium, baneberry, columbine, anemone, hepatica, buttercup, mayapple, bloodroot, dutchmansbreeches, violet, Indianpipe, and beechdrops.

In zone D, the Canadian-Transition zone, red spruce (*Picea rubens* Sarg.), balsam fir (*Abies balsamea* (L.) Miller), and American mountain-ash (*Sorbus americana Marsh.*), are dominant, with maple, beech, yellow birch, and white pine as in zone C. The herbaceous undergrowth includes ferns, hobblebush (*Viburnum alnifolium* Marsh.), true wood sorrel, moss, and ground hemlock. Other less abundant herbaceous plants in this zone, although occurring in zone C, are red elder, bush-honeysuckle, wild-sarsaparilla, and aster.

In addition to the trees given in the indicator lists, many other trees are fairly numerous. These include pitch pine (*Pinus rigida* Mill.), aspen or American popple (*Populus tremuloides* Michx.), bigtooth aspen or popple (*P. grandidentata* Michx.), paper birch (*Betula papyrifera* Marsh.), gray birch (*B. populifolia* Marsh.), and American larch (*Larix laricina* (DuRoi) K. Koch). Wild blackberries, huckleberries, and blueberries grow in many places.

Practically all of the chestnut has succumbed to blight. Many dead trees remain to attest their former abundance in the southern part of the county. Sprouts are very common about the dead trees, although few reach very great size before succumbing to the blight. On the Shawangunk Mountains a few sprouts were producing chestnuts again when the survey was made (1938).

Rhode Island bentgrass is common in all parts of the county and to a lesser extent are also redtop, Kentucky bluegrass, and timothy in the pastures. Poverty oatgrass, a weed grass, is also very common, and in many areas of soils developed from gray sandstone material it is dominant. Other fairly common good grasses and legumes are orchard grass, meadow fescue, wild white clover, alsike clover, and red clover. Other grasslike weeds in the pastures are quackgrass, summer foxtail or yellow bristlegrass (*Setaria lutescens* (Weigel) F. T. Hubb.), sedges, and rushes.

Besides the grasslike weeds already mentioned, many plant pests grow in the poor pastures, and especially those on soils developed from the gray sandstone materials. These are devils-paintbrush, ox-eye daisy, buttercup, yarrow, sheep sorrel, cinquefoil, strawberry, Canada thistle, mullein, narrow-leaved plantain, ragweed, hardhack, mosses, and ferns.

ORGANIZATION AND POPULATION

Little is known of the early history of Sullivan County. The aborigines were principally Esopus Indians, who were members of the Wolf clan of the Lenni-Lenape, or Delaware tribe (*12*). Traces of the white man's occupation antedate the earliest records of the history of the county. The early settlers found a road extending southward from Esopus on the Hudson River, along the valley north of the Shawangunk Mountains. It was known as the mine road, and according to traditional account it was built by a company of miners from Holland before the English conquest of 1664.

Ignoring vague traditions, it may be said that the first permanent white settlement was made about 1700 by a Spaniard, Don Manuel Gonzales, in the valley called Mamakating Hollow. Other settlers, mainly of Dutch descent, soon followed. About 1750 a number of German families settled upon the western frontier of the county. The Newburgh and Cochecton turnpike, opened in 1808, gave the first impulse to prosperity in the county by making it accessible to settlers who came from New England and the older parts of the State. Many were of English, Scotch, and Irish descent.

On March 27, 1809, the county was created from a part of Ulster County and was named in honor of Maj. Gen. John Sullivan, of the Revolution. The building of the Delaware & Hudson Canal in 1828 was of great importance to the early settlers, as it opened an easy and cheap avenue to the market. Soon after the opening of the canal, the lumbering, tanning, and gristmill operations expanded very rapidly. The canal was abandoned in the latter part of the last century, owing to competition from other means of transportation.

In the decade after 1845 the population increased over 50 percent, reaching 29,487 in 1855 (*3, p. 151*). Thereafter the population increased more gradually, and in 1870 it was 34,550. Between 1870 and 1890 there was a migration from the county, after which time there were slight increases in the population. According to the Federal census for 1940, the population was 37,901. Of the total, 30,376 persons, or 80.1 percent, were classed as rural, and 7,525, or 19.9 percent, as urban population. About 6,052, or 16 percent, of the population are foreign-born.

Monticello, the county seat, with a population of 3,737, is slightly southeast of the center of the county. Most of the main highways to the resort areas of the county radiate from Monticello. It is an important resort town itself and has many summer hotels and boarding houses. Liberty village, the only other village in the county listed as urban in the census, has a population of 3,788. It is also an important resort town and health center. Many persons affected with tuberculosis come to the various rest homes here, atmospheric conditions being considered very favorable for those suffering with pulmonary diseases.

A sanatorium is 2 miles west of Liberty village at Loomis. Important villages and trading or recreational centers are Roscoe, Livingston Manor, Grahamsville, Neversink (community), Woodbourne, Centerville, Wurtsboro, Eldred, Smallwood, Barryville, Narrowsburg, Callicoon (community), Long Eddy, White Lake, and Jeffersonville. A State prison is in Woodbourne, and the county home for the poor and aged is located at Thompsonville, a small hamlet 3 miles northeast of Monticello. Many hamlets in the county are important resort centers and have a large summer population.

INDUSTRIES

The original forest was cleared or cut over at an early date. Wherever sufficient water power was available, gristmills and sawmills sprang up. With the development of transportation, lumber mills and tanneries were built everywhere and represented the most important early industries of the county. Some idea of the magnitude of these industries can be gained from the fact that 203 sawmills were in operation as late as 1845 and that as much as 8,567,872 pounds of sole leather was manufactured in the county. In the southwestern towns lumbering continued to be the most important industry until comparatively recent years. In order to clear the land in many places the timber was cut and burned. Some money was obtained from the sale of potash and charcoal.

After 1845 lumbering and tanning began to decline, and today lumbering is a minor industry; nevertheless over half the area of the county, to a large extent the areas less suitable to cultivation, remains in forest. The present forest consists of second growth and forest plantations. At present most of the lumber cut is done with portable mills moved from place to place wherever the mill operators are able to buy timber. The forests are usually left in poor condition after the mill operators are through with their cutting. Usually only the choice timber is cut, culls and trees damaged during logging are left, and no care is given to the disposal of slash to reduce fire hazard. About 799,000 board feet of lumber was cut in 1939, according to the United States census for 1940. A few farmers cut ties for the railroads during the winter. The demand for ties, however, fluctuates considerably. Much wood is cut for firewood, which is used locally by the farmers themselves, by the village people, and the local hotels.

A plant manufacturing charcoal, wood alcohol, and acetate of lime has been in operation for some time north of Roscoe. A furniture factory in Roscoe cooperates with the acetate plant in utilizing wood, having a capacity for using 5,000 cords a year. Hardwoods are used in the process of distillation. Large tracts of forests are cut over for this purpose. There is very little waste wood left in the forests after the cuttings are made, as nearly all of the material down to a 2-inch diameter is used in the plants. Although the fire hazard is not so great as it would be if such small trees were not used, the erosion hazard becomes rather grave, since the forests in many places are clear cut. A last-block and bowling-pin factory is operated at Livingston Manor. Mostly maple is used in this plant. A creosote plant for treating railroad ties is also operated here by the New York, Ontario & Western Railway. Some of the ties treated, however, come into Sullivan County from other places along the line.

There are no large nonagricultural manufacturing industries in the county. One small blanket factory, which has been running for many years, is still in operation at West Brookville. The number of employees, however, is very small. The light and power company hires several men at its three reservoirs and power plants.

TRANSPORTATION AND MARKETS

The Erie Railroad and the New York, Ontario & Western Railway afford direct communication with New York City. The main New York to Buffalo line of the Erie Railroad enters the western part of the county at Tusten Station and follows the eastern shore of the Delaware River northward into Delaware County. Freight and passenger service is very good along this line. Several trains run daily throughout the year. The New York, Ontario & Western Railway and its branch lines serve the central and southeastern parts of the county. Passenger trains do not run so frequently on this line, especially after the resort season is over. Special trains run in the summer from New York City. This line enters the southeastern part of the county south of Winterton and leaves the county north of Roscoe, where it follows along the valley of Beaver Kill. A branch line serves the southern part of the county, and from here a line extends to Monticello.

Good highways serve all towns. There are approximately 1,757 miles of roads in the county. Figures furnished by the county highway department in 1938 show that 604 miles of roads are hard-surfaced, 481 miles improved by gravel, and 672 miles unimproved or of dirt. The State maintains 192.5 miles of highway, all of which is hard-surfaced. The county maintains 287 miles, of which 253 miles is hard-surfaced and the rest is improved gravel road. For the most part the State and county roads are well maintained and are kept free from snow by the respective highway departments. The dirt roads in the towns are fair. They are often very rough but seldom impassable except when blocked by snowdrifts and at times when spring thaws make short stretches impassable for automobiles.

Of the 2,778 farms reported by the 1940 census, only 1,320 are on hard-surfaced roads, 239 on roads made of gravel, shale, and shell, 597 on improved dirt roads, and 556 on unimproved dirt roads; and 66 farms were not accounted for in the report.

Most of the farm produce is shipped to New York by motortruck and some by rail. In the summer there is a large market for farm produce at the local hotels, boarding houses, and summer camps. Many farm homes keep summer boarders and use their own produce. Some vegetables and considerable poultry are marketed locally to the hotels. Many hotels, however, buy their produce from the New York City markets and have it shipped in by motortruck. Apparently it would be practicable to establish a local farmers' cooperative market to sell summer produce to the local hotels.

CULTURAL DEVELOPMENT AND IMPROVEMENT

Good school facilities are provided throughout the county. Sullivan County is divided into three supervisory districts,[4] each under a district superintendent. District 1 contains 25 schools, district 2, 19

[4] The information on schools was furnished by Alfred J. Wiesmann, Superintendent of Schools, Monticello, N. Y.

schools, and district 3, 58 schools. Motorbus transportation to the larger schools is furnished for children living at considerable distances from the schools.

Nearly every small community has one or more churches. Monticello and Liberty support several churches of different denominations. Rural mail delivery service covers practically all of the county.

Hotels are the most important nonagricultural enterprise in the county, because the county has become such a summer vacation land for many New York City residents. Interest in winter sports is developing rapidly, and several of the hotels are now operating throughout the year.

Many of the farm homes have modern improvements, made possible by profit from boarders. Although the number of farms having telephones is low (47.1 percent), the 1940 census shows that 2,030 farms, or 73.1 percent of all farms, have electricity. With the recent extension of electric lines brought about by the rural electrification program, the number of farms having electricity has been increased since 1930. A total of 2,251 automobiles were reported on 1,966 farms, or 70.8 percent of all farms; 787 motortrucks on 721 farms; and 289 tractors on 273 farms. Most of the dwelling houses are large and well kept.

The equipment of the farms is adequate for the type of farming followed. The barns, except those on the larger dairy farms, are small, and many are unpainted. Because the health and sanitary requirements for selling milk are strict regarding the housing of dairy cattle, the dairy barns are generally kept in good condition. Most dairymen have silos. As most of the dairy herds are small, very few power milkers are used. Most farms are equipped with mowing machines, hay rakes, spring-tooth harrows, wagons, manure spreaders, lime and grain drills, and cultivators. The small acreage of tillable land and the fact that very little grain is harvested make grain binders and threshers unnecessary on many farms. In fact, much of the grain harvested is cut with a reaper and threshed with a flail. Likewise, the small acreage of tillable land and to some extent topographic features do not justify tractors.

AGRICULTURE

Agriculture began in the area that is now Sullivan County about 1700, when the first permanent settlers located in Mamakating Hollow. They raised grain (*11*) and opened trade with the Indians. Their produce was hauled over the old mine road to the Hudson River. Elsewhere the early agriculture was simple and consisted largely of the production of subsistence crops for the home. The early settlers were isolated from more populous centers by mountains and by the lack of roads and navigable streams. Game was plentiful in the forests, and hunting and lumbering were important occupations.

The building of the Newburgh and Cochecton turnpike in 1808 gave the first important impulse to development. It opened the county to the outside markets and encouraged immigration. Farming increased with the influx in population, but still it was mostly on a subsistence basis, as products reached outside markets only at great expense of hauling over mountain roads. With the opening of the Delaware & Hudson Canal in 1828 an easy and cheap avenue to the market was made. Although leather and lumber were the chief

exports in the early days of the canal, exports of farm produce increased as the virgin timber stands became exhausted. During this early period the leading crops grown were corn, oats, rye, wheat, buckwheat, and potatoes. Livestock raising and the production of maple sugar were important enterprises also.

Since the manufacture of lumber and the tanning of hides were much more profitable than farming in early times, the development of agriculture was consequently somewhat slower.

By 1845, however, the lumber industry began to decline and farming began to receive greater attention. The area of improved land in the same period increased from 50,674 acres in 1835 (4) to 68,525 acres in 1845, according to the State census. At that time more livestock was raised than at present. A census of 1845 gives the following numbers of livestock: All cattle, 25,507; horses, 2,958; sheep, 19,545; and hogs, 9,808. Nevertheless the numbers of livestock did not reach a maximum until about 1890, which is also the peak period of farming in the county.

Much of the farm labor is done by the farmer and his family. The expenditure for farm labor in 1939, however, was $267,037, or $294.42 for each of the 907 farms reporting. Most of the laborers are native white, and in 1937–1938 the supply was sufficient to meet the demand. In this county, where dairy and poultry farms prevail, some hired labor is employed the year round. Day help is employed more often during busy seasons to assist in harvesting the hay crop and filling the silos.

Although no hay or grain is sold out of the county, farmers buy nearly all of the grain used for dairy stock and most of the grain for horses. Some hay is bought outside of the county. Most of the oats is cut green as a hay crop, although some is threshed for horses. A large quantity of concentrated feed is sold to dairymen and poultrymen. The total expenditure in 1939 was $1,460,747, reported by 2,435 farmers. The purchased feed consists mainly of 18- and 20-percent protein feeds.

The percentage of farms operated by owners has always been very high in Sullivan County. In 1940 owners operated 92.4 percent of the farms, tenants 7.0 percent, and managers 0.6 percent. There has been very little change of ownership of farms in recent years. The systems of rentals to the few tenant farmers vary. Most tenants pay cash rent, but some are share-crop tenants. Under one form of rental on dairy farms the owner furnishes the livestock and pays the taxes and the tenant furnishes the fertilizer and dairy feed, and the profits are divided equally.

Land values range widely from the rather low value of land purchased by the State within the Catskill Forest Preserve in the northern part of the county, where a number of farms have been abandoned, to much higher values for hotel sites. The average value of farm land and buildings in 1940 was $77.63 an acre and $7,106 a farm. Influenced by a higher real estate value of the land for resorts, the average value of farm land is generally higher in Sullivan County than in the State as a whole.

CROPS

The crop sequence or rotation in common use is as follows: (1) Corn, (2) oats (seeded with timothy and clover), and (3) timothy

and clover, remaining in mowing from 3 to 4 years. The average rotation is 5 years in more intensively farmed areas.

Although much of the land is sloping to steeply sloping, very little strip cropping is practiced. This condition is due in part to the present lay-out of farm fields, which are, in places, small and surrounded by broad stone fences, and to the fact that much of the land is in grasses or pasture. Practically no use is made of cover crops for the control of erosion.

Plowing is done in spring and fall, about half being done in fall and half in spring. Fall-plowed land has the advantage of freezing and thawing, resulting in more even bedding of the soil than in spring-plowed land. Fall plowing also results in more thorough incorporation of organic matter and the destruction of many hibernating insect pests. Land to be prepared for oats is plowed in fall when possible, or it may be plowed early in spring. Spring preparation of plowed land consists of thorough harrowing and in some places of disking.

The income on many farms is supplemented by receipts from summer boarders. Maple sugar or sirup is produced on several farms in the county. Although the quantity produced annually is not large, there is a good home market for the products. In 1939, 3,192 gallons of sirup and 444 pounds of sugar were produced.

The present agriculture is based on dairying and poultry raising, and the crops produced are mainly in support of these activities, although some subsistence crops also are grown. Under this system, silage, grain, and hay are the main crops, and vegetables for home use and market are minor crops. Timothy and clover hay, alfalfa, sweetclover, corn for silage, and oats are grown to support dairying and to maintain the work animals. Grain corn and other grains, principally rye and wheat, are grown to support poultry. Potatoes and other vegetables are raised chiefly for home use but to some extent as cash crops.

Table 3, giving the acreages of the principal crops as reported by the Federal census, shows the trend of agriculture for the last 60 years.

TABLE 4.—*Acreage of the principal crops in Sullivan County, N. Y., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn, all					5,855	3,906	4,940
For grain	7,426	3,844	0,777	4,632	3,632	559	956
For silage and fodder					[1] 2,223	3,437	3,984
Oats, all						2,988	2,708
Cut for grain	11,470	9,630	7,742	5,069	6,742	1,880	1,700
Cut and fed unthreshed						1,108	1,008
Rye	8,339	3,215	3,778	1,715	1,951	138	39
Buckwheat	10,864	6,522	5,988	5,091	3,594	734	222
Potatoes	3,568	2,871	3,466	3,312	2,810	1,171	1,002
Market vegetables					142	150	433
Hay, all	77,085	82,464	72,148	71,996	64,736	59,524	52,875
Timothy and clover, alone or mixed				30,637	28,601	38,165	26,953
Sweetclover						31	414
Alfalfa				31	60	285	277
Grain cut green			303	720	2,071	637	1,588
Other tame hay			71,675	29,908	33,555	19,828	21,860
Wild grasses			110	700	449	578	1,783
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples		[2] 192,016	[3] 100,045	159,258	129,541	[4] 64,048	[5] 24,422
Pears				6,762	7,380	[4] 1,887	[5] 1,269

[1] Cut for forage only. In addition 2,785 acres of silage crops were reported, most of which probably was corn.

[2] For the year 1890. [3] For the year 1900. [4] For the year 1930. [5] For the year 1940.

Timothy and clover, the leading hay crop, are grown on practically every farm. Clover is rarely seeded alone. Medium red and alsike, the most popular kinds, are grown in combination with each other and timothy. Timothy, alsike clover, and red clover are seeded at the rate of 15 to 18 pounds to the acre. Very little mammoth clover is grown, as it grows too rank on the better soils, lodges, and dries slowly. Timothy is sometimes sown alone. Alfalfa, both Grimm and Ontario variegated, is grown, but generally in combination with clover. Very little sweetclover is grown. Ladino clover is a promising perennial legume well suited to most soils on which alfalfa cannot be grown. Although the present acreage is small, it is expected to replace red clover in seeding mixtures on many farms.

Oats, grown as a nurse crop, are the leading grain crop. Most of the grains are cut and fed green. Oats are seeded at the rate of from 2 bushels an acre when seedings are made early to 2½ bushels if seeding is made late. Much less land is planted to oats now than formerly. Only a small acreage of other small grains is grown. Rye is used for pasture. The acreage of mixed grains and wheat is small. Buckwheat is grown mainly on soils that do not produce high yields of other crops or as a catch crop, and its acreage has been gradually decreasing. A small quantity of buckwheat is ground into flour, and the rest is fed to poultry and livestock.

The acreage in corn increased somewhat between 1929 and 1939, but it is much smaller than in 1879. It is the principal silage crop. Only 956 acres out of a total of 4,940 acres were harvested for grain in 1939, and most of the rest was cut for silage. Cornell 11, West Branch Sweepstakes, and Luce Favorite are varieties commonly grown. Luce Favorite is being replaced by higher producing varieties. The later maturing varieties, such as West Branch Sweepstakes, are grown mostly in the valleys near Wurtsboro and Bloomingburg where growing seasons are longer than on the adjacent uplands or in the northern part of the county. Average yields of corn for silage are about 10 tons, but 15 or 20 tons an acre are obtained in favorable seasons on the better soils if well managed.

Japanese millet has become popular in recent years as an emergency hay crop and to some extent as silage. Millet is planted around June 15 at the rate of 15 to 16 pounds an acre. Interest in grass silage is increasing. The silage is treated mostly with molasses and in a few cases with phosphoric acid. About 60 pounds of molasses is required for each ton of forage. This should be diluted one-half with water. From 16 to 20 pounds of commercial phosphoric acid is required for each ton of silage.[5]

Larger acreages of potatoes have been grown than at present. However, potato yields have always been low here as compared with other areas of the State. In 1939, 73,045 bushels were harvested from 1,002 acres, an average yield of 72.9 bushels an acre, as compared with an average of 132 bushels for the State. The varieties now grown are Number 9, Irish Cobbler, and to some extent Green Mountain.

[5] WILSON, J. K. MOLASSES AND ACIDS AS SUPPLEMENTS IN SILAGE MAKING. N. Y. State Col. Agr. Agron. Mimeog. 425, 2 pp. June 21, 1937.

Although vegetable gardening is the principal source of income on a few farms, most farms do not raise vegetables for market. Considering the large number of summer residents, there should be a large market for vegetables within the county in addition to the one in New York City. Many soils are similar to those in Delaware County, where cauliflower is an important crop. Climatic conditions may be a limiting factor in some areas in Sullivan County. The acreage of sweet corn, tomatoes, and cabbage has increased considerably since 1929.

FERTILIZERS

Very little is spent for commercial fertilizers. The 1940 census reports only $27,996 spent for commercial fertilizer on 742 farms and $32,499 for liming materials on 955 farms in 1939. The use of lime is desirable and profitable, especially in obtaining stands of leguminous crops. Some hydrated lime but mostly 90-percent ground limestone is used. Manure is depended on mainly for keeping up the fertility of the land. Manure is generally applied at the rate of 10 tons an acre on cornland. It is often used as a top dressing on meadows and occasionally on pastures. About half of the farmers use superphosphate, generally 16- to 20-percent superphosphate applied at the rate of 400 pounds an acre for seedings and on cornland. The use of this fertilizer is definitely on the increase. Lime is applied for seedings at the rate of 1 ton an acre. This is rather low for some soils, however. Very little commercial fertilizer is used in rotations. Vegetable growers use from 300 to 1,200 pounds an acre of comparatively high analysis commercial fertilizer.

PASTURE LAND

Although pastures are so important in this, a dairy county, very little attempt has yet been made to improve them or even to maintain them in reasonably good condition. Because the rainfall and comparatively low summer temperatures are favorable for the growth of grass, most farmers apparently have been content to allow pastures to take care of themselves. Close botanical examination, however, shows that much of the pasture now contains a large percentage of poverty oatgrass and that encroachments of devils-paintbrush and other weeds are common.

A large part of all the farm land is in pasture. So large a proportion of pasture land on the average farm, considering the small numbers of livestock kept, is an indication of low productivity of pasture grasses despite favorable climatic conditions. If properly carried out, improvement should result in a greatly increased stock-carrying capacity. Under present economic conditions, however, it should be well to restrict this improvement to the better pasture land on the farm. If 1 acre of pasture is improved for each cow or equivalent livestock on the farm, this should provide sufficient pasturage after a few years and should make it possible to retire from agricultural use land that is ill adapted for pasture.

As in New York State as a whole, so in Sullivan County a deficiency of available phosphorus is the primary cause of the poverty and low productivity of the pastures. This was well illustrated by experiments on similar soils, Lackawanna and Walton soils, in Delaware County (*5*). The pastures from which these soils were taken showed

a satisfactory and profitable response to the application of 800 pounds of superphosphate an acre alone. The soils of Sullivan County, however, are highly acid and would require applications of 2,000 to 4,000 pounds of ground limestone an acre to insure a satisfactory growth of red clover. The experiments show that while superphosphate alone produces a satisfactory improvement in both soils, the acidity, especially of the Lackawanna soil, is too high for the satisfactory growth of wild white clover, and that an application of 2,000 pounds of lime an acre, in addition to superphosphate, produces a sufficiently better result to justify the increased cost. Although little response was obtained from potash in the experiment on Delaware County soils, indications on some soils in Sullivan County would suggest that a light application of potash would be profitable, especially on the Catskill soils.

Nitrogen is almost as deficient as phosphorus in the pasture soils of the county, and the provision of an adequate supply of nitrogen is essential in pasture improvement. Fortunately this does not necessarily mean the application of expensive nitrogenous fertilizers. Most pastures contain a plant that is capable of supplying the nitrogen required when satisfactory conditions for its growth are provided. This plant is wild white clover, and it should be looked upon as the key to pasture improvement. One small plant present to the square yard is often sufficient, as the growth habit of wild white clover enables it to spread very rapidly if fertile conditions are provided. Experiments at Cornell University have shown the remarkable influence of the plant in the improvement of pastures. Other pasture legumes through which the nitrogen can be supplied are wild birdsfoot deervetch, or birdsfoot trefoil, and black medic, or yellow trefoil.

The recommended pasture mixture for the establishment of new pastures by seeding is the Cornell Pasture Mixture for 1938 (*6*).[6] It was designed with the object of producing a uniformly high yield of nutritious herbage throughout a grazing season of about 6 months. It is adapted only for soils adequately supplied with fertilizer and lime and for fields that are properly grazed. The mixture is as follows:

	Pounds per acre
Kentucky bluegrass (*Poa pratensis* L.)	8
Canada bluegrass (*Poa compressa* L.)	2
Rough bluegrass, or rough-stalked meadowgrass (*Poa trivialis* L.)	1
Timothy (*Phleum pratense* L.)	6
Perennial ryegrass (*Lolium perenne* L.)	5
Black medic, or yellow trefoil (*Medicago lupulina* L.)	2
Wild white clover (*Trifolium repens* L.)	1
Total	25

In the establishment of new pastures by seeding, one should strive for a mixture of grasses and legumes well suited to soil and climatic conditions. Wild white clover and Kentucky bluegrass are commonly the basic ingredients of a good, long-lasting mixture in which the

[6] One should consult his county agricultural agent concerning changes that may be made in this mixture in the future as a result of experimental work in progress, and for sources of seed specified. Information concerning mixtures adapted to special local conditions may be obtained from the Department of Agronomy at Cornell University, Ithaca, N. Y.

clover fixes nitrogen from the air when well supplied with lime and phosphorus. The clover adds to the quantity and quality of feed produced both by its own production and by increasing the yield and quality of the associated grass. Ladino clover, a giant type of white clover, is becoming increasingly popular in such mixtures for pastures that are not extremely droughty. It is long-lived, spreads by runners, and grows larger than wild white clover. In very droughty pastures, as well as in others, birdsfoot trefoil, a plant that resembles alfalfa, has been used successfully as the legume in such mixtures. Yellow trefoil, a plant that spreads by seed, is sometimes included. Grasses that should be considered are Kentucky bluegrass, Canada bluegrass, rough-stalked meadow grass, pasture types of timothy, perennial ryegrass, and orchard grass, but Kentucky bluegrass is generally the basic grass ingredient on most soils. The county agricultural agent should be consulted about the mixture best suited to a particular soil. Information concerning various mixtures suited to particular conditions can also be obtained from the Department of Agronomy, Cornell University, Ithaca, N. Y. Whatever mixture is used, success depends upon adequate supplies of plant nutrients in the soil. Lime and phosphorus are generally needed on the soils of this county, and there is increasing evidence of the need for potash on many soils.

LIVESTOCK AND LIVESTOCK PRODUCTS

The total number of cattle has not varied greatly; but an increasing number of dairy cattle are being raised, whereas the number of beef cattle is declining. On April 1, 1940, the 26,271 cattle over 3 months of age were largely of dairy breeds. Holstein-Friesian is the most popular breed, and herds of Ayrshire and Guernsey are common. Many herds are mixed. In 1939, 9,443,357 gallons of milk was produced, of which 7,569,282 gallons, valued at $1,286,778, was sold as fluid milk. The value of other dairy products sold amounted to $23,046. The shift from the production of butter and cheese to the production of fluid milk is due largely to the excellent roads and railroads for rapid transportation to New York. In 1939, 3,682 cattle and 8,191 calves were sold alive, and 198 cattle and 410 calves were butchered on farms.

Although dairying is the most important single enterprise, it is practiced less intensively in the area than in some of the more important dairying sections of the State. On the basis of 1929 census data, milk production averages 5,100 pounds per cow, which is slightly higher than the average in the adjoining counties, Ulster and Delaware, but 300 pounds lower than the average for the State. This difference is probably due in part to the fact that the average number of cows per farm is low as compared with the average number in other counties, and many of the pastures are poor.

Sheep raising was important in the early agriculture. In 1845 the number of sheep in the county was 19,545, but the number declined, with the exception of the Civil War period, until on April 1, 1940, only 507 sheep over 6 months of age were reported. Most of the sheep raised at present are kept in small flocks in the towns of Fremont, Liberty, and Neversink. A considerable area of land is available for pasture, but it is doubtful whether the number of sheep will increase

appreciably in the county. Only 258 sheep and lambs were sold alive in 1939, and 111 were butchered on farms.

Although the raising of hogs is comparatively unimportant at present, early history tells of great numbers of swine grazing in the forests of the county, where they fed on beechnuts, chestnuts, and acorns. The 1940 census reports only 1,432 hogs over 4 months of age. In 1939, 2,143 hogs and pigs were sold alive, and 2,819 were butchered on farms.

Horses are used for most of the farm work, and the average number kept on the farms reporting horses is about two. Very few horses are raised in the county, as most of them are shipped in from the Midwest. On April 1, 1940, there were in the county 3,313 horses and 58 mules over 3 months of age.

Poultry raising ranks next to dairying in importance as a source of farm income. Poultry production has increased very rapidly since 1910. The value of poultry and poultry products sold in 1939 was $925,464. There is a large home market for eggs and dressed poultry during the hotel season; during other periods most of the produce is shipped to New York City. In 1939, 742,764 chickens were raised, of which 422,640 were sold alive or dressed, and 3,169,942 dozen eggs were produced. Poultry production will probably increase in this county. White Leghorn is the most popular breed, although some New Hampshire Red and a few Plymouth Rock flocks are kept.

TYPES OF FARMS

The decade 1845–55 was the greatest period of expansion in the history of the county, undoubtedly brought about by the opening of the Erie Railroad in 1848. Following the trend in population, the amount of the improved land in the county was almost doubled, reaching a total of 125,489 acres in 1855 (*3, p. 108.*) With this expansion a marked change in agriculture was brought about. The number of swine, sheep, and oxen kept began to decrease as horses and milk cows increased. More land was used for agricultural crops, and the production of grain, potatoes, apples, and butter increased.

Table 4 gives data as to farms from 1880 to 1940, as reported by the Federal census.

TABLE 4.—*Number and size of farms and farm areas in Sullivan County, N Y in stated years*

Item	1880	1890	1900	1910	1920	1930	1940
Farms.....number..	4,394	4,096	3,887	3,851	3,543	2,979	2,778
Land in farms.....percent..	73 6	71 4	74.7	70 4	64 7	44 7	40.3
Area per farm.....acres..	107 0	112 0	123 2	117 2	117 1	96 2	91.5
Farm land improved.....percent..	44 9	47.8	42 0	42 7	37 3	41.0	46 9
Improved land per farm.....acres..	48.0	53 4	51.7	50.1	43 6	39 5	43.0

Since 1900 the average size of farms has gradually decreased from 123.2 acres to 91.5, although the number of farms has likewise decreased. Much of the land that has gone out of agriculture has been used for hotel developments, and some has been bought up for reforestation in the Catskill Forest Preserve. The average number of acres of improved land has decreased from 53.4 acres per farm in 1890

to 43.0 acres in 1940. Shortly after 1910 many of the large farmhouses were bought up for boarding houses and hotel purposes. Many of these farms were situated on the better soils and had large acreages of improved land. The land was no longer farmed, as the hotel business rapidly developed; consequently farming has had to continue on the areas of poorer soils, some of which are not profitable to improve.

According to the 1940 census, 254,304 acres, or 40.3 percent of the area of the county, is in farms. Of the farm land, 70,232 acres was classed as cropland in 1939, 49,152 acres as plowable pasture, 86,986 acres as woodland, and 47,934 acres as other land. Improved land (plowable pasture and cropland) totaled 119,384 acres in 1939.

The land outside of farms consists mainly of the land included in the Catskill Forest Preserve, private hunting parks, and camp areas, the light and power company's watershed areas, and the area within Monticello and Liberty and in the many smaller villages, hotel sites, roads, and railroads.

The number of farms reached a maximum of 4,394 in 1880, and since that time both the number and the average size have decreased. In more recent years farming has concentrated in the better areas in Callicoon, Liberty, Fallsburgh, Neversink, Fremont, Bethel, Cochecton, and Thompson.

Of the 2,778 farms in the county reported by the 1940 census, 884, or 32 percent, included less than 50 acres; 861, or 31 percent, ranged from 50 to 99 acres; 788, or 28 percent, ranged from 100 to 179 acres; and 245, or 9 percent, included 180 acres or more. In 1939, 872 farm operators, or 31 percent of all farm operators, had part-time employment off the farm for an average of 144 days.

FOREST LAND

Reforestation of nonagricultural and idle land has gradually increased since 1909, when 3,000 trees were planted. Up to the present (1938), a total of 2,643,430 trees have been planted throughout the county outside of the Catskill Forest Preserve, where several thousand trees have been planted by the State. Most of the seedlings used are white pine, red pine, Scotch pine, or black locust, and some are Norway spruce, white spruce, northern white-cedar (*Thuja occidentalis* L.), and European or eastern larch (*Larix laricina* (DuRoi) K. Koch). Plantings within the county have been made by the county, towns, highway departments, railroads, light and power company, recreational organizations, 4–H clubs, and farmers, and now (1938) total 95,500 trees.[7]

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings are made at frequent intervals, and fresh exposures, such as those in road or railroad cuts, are studied. Each excavation or boring exposes a series of soil layers, or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is

[7] Figures furnished by the Forestry Department of the New York State College of Agriculture.

studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [8] and its content of lime (calcium carbonate) are determined by simple tests.[9] The drainage, both internal and external, and other external features, such as stoniness and the relief, or lay of the land, are taken into consideration and the interrelation of the soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, with special emphasis on the features that influence the adaptation of the land for the growth of crops, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the principal ones of which are (1) series, (2) type, and (3) phase. Some areas of land, such as riverwash or rough mountainous land, that have no true soil are called (4) miscellaneous land types.

The most important of these groups is the series, which includes soils having genetic horizons similar as to differentiating characteristics and arrangement in the soil profile, except for the texture of the surface soil, and having similar parent material. The series comprises soils having essentially the same color, structure, natural drainage conditions, and other important internal characteristics, and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may differ within a series. The series are given geographic names taken from localities near which they were first identified. Lackawanna, Catskill, Walton, Culvers, and Norwich are names of important soil series in Sullivan County.

Within a soil series there are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of this texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, or clay, is added to the series name to give the complete name of the soil type. For example, Walton gravelly loam and Walton silt loam are soil types within the Walton series. Except for the texture of the surface soil, these types have approximately the same internal and external characteristics. The soil type is the unit of mapping, and because of its specific character it is usually the unit to which agronomic data are definitely related. In comparisons of the type and phases of that type, to avoid the repetition of their complete names, the type is sometimes referred to as the normal phase.

A phase of a soil type is a subdivision of a soil unit or soil type having minor variations in characteristics used in soil classification from the characteristics normal for the type, although these variations may be of great practical importance. The variations are chiefly in such external characteristics as relief, stoniness, or accelerated erosion. For example, within the normal range of relief for a soil type, some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Even though no important differ-

[8] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates neutrality, higher values alkalinity, and lower values acidity.

[9] The presence of lime is detected by the use of a dilute solution of hydrochloric acid. Indicator solutions are used to determine the reaction.

ences may be apparent in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, important differences may exist in respect to the growth of cultivated plants. On such land the more sloping parts may be separated on the map as steep or hilly phases. No phases showing degrees of relief are shown on this map, as fairly accurate topographic maps [10] were joined to make a base map, and the variations in the degree of slope are indicated by the density of contour lines within a unit area. Soils having differences in stoniness or depth to bedrock may also be mapped as phases. Thus, Lackawanna silt loam, shallow phase, represents a soil phase in this county.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The soils of Sullivan County [11] differ considerably in color, texture, consistence, depth, stoniness, moisture, and, to a less extent, in fertility and acidity, all of which characteristics bear a relation to productivity and crop adaptation. They exhibit all shades of color from dark gray through the lighter shades of gray to light red. They range in texture and consistence from friable silt loam to loose incoherent sand, but silt loam is the most extensive. Most of the soils of the uplands in the northern and western parts of the county are silt loam, whereas most of those in the eastern and southern parts are loam. The soils of the river bottoms, terraces, and kames of the valley range from silt loam to loose sand. About 60 percent of the area of the entire county is either silt loam or stony silt loam.

Although the soils vary considerably in color, the soils in about 60 percent of the area are light red or grayish red and are developed from parent material composed of Indian-red sandstones and shales. About 30 percent of the soils are gray and are developed from parent materials composed of fragments of gray sandstone, and about 10 percent are yellowish brown and are developed from parent material composed of a mixture of conglomerate and Hudson River shale material.

On the uplands, the soils, with a few exceptions—namely, shallow soils overlying bedrock—have compact hardpan subsoils. The soils in general are more or less stony. Most of the soils of the uplands have good surface drainage. Owing to the prevailing hard subsoils, thorough internal or subsoil drainage is lacking in about 30 percent of the area of these soils, as in the Culvers and Wellsboro soils.

The soils are not especially fertile, but none is sufficiently unproductive to be barren. The most fertile soils are the reddish-gray soils of the upland and the heavier textured alluvium. All the soils

[10] Issued by the U. S. Geological Survey.

[11] Sullivan County adjoins Delaware County on the north, Ulster County on the east, and Orange County on the south, and in places the soil maps of these counties do not appear to agree (7). This is due, in most places, to changes in correlation resulting from a fuller understanding of the soils of New York. For instance, the Catskill and Liberty soils mapped in Sullivan County were not recognized at the time the adjoining counties were surveyed.

are decidedly acid in reaction in their upper layers, and in most places this holds true to a depth of several feet.

In the valleys are two groups of soils, one consisting of old alluvium, in part at least laid down a long time ago by streams flowing from glacial ice, and the other of more recently deposited alluvium. The old alluvium designated here as outwash deposits, in contrast with the soils of the uplands, is in many places coarser or less uniform in texture, has a porous subsoil, and generally has a smaller content of large stones. The recent alluvium occupies the lowest lying positions and consists of deposits of varying textures.

Dairying is the dominant type of agriculture in the county, and the cropping system is adjusted accordingly. The natural features of the land surface have influenced the growth of this industry. The rugged and steep character of much of the county is not favorable to extensive production of grain, vegetables, or intertilled crops. Because the high rainfall and the comparatively low summer temperatures are favorable for the growth of grass, farmers many years ago realized the suitability of the area for livestock raising. Also, economic factors, principally the nearness to the large markets of New York City and the local summer market, tend to make dairying and poultry raising very important agricultural pursuits.

The developed farm land areas of the county follow closely the more fertile valley soils and the grayish-red soils of the uplands. The most intensively farmed area extends east and west through the central part of the county. Outside of this area most of the farms are along the valleys.

In classifying the soils [12] a number of soil characteristics or features were considered. In any one county or area, however, some of these characteristics bear a closer relation than others to the cropping value or adaptability of the soil. The soil features that are most significant agriculturally here are drainage conditions, relief, consistence (or degree of tightness, stickiness, or toughness of the subsoil), texture (or proportions of sand, silt, and clay constituting the surface soil material), and physiographic position. For the purpose of discussion of their relative productivity and adaptation, or relation to agriculture, the soils are grouped on the basis of these features.

The soils may be separated on the bases of physiographic position and drainage into six groups: (1) Well-drained soils of the uplands; (2) imperfectly drained soils of the uplands; (3) poorly drained soils of the uplands; (4) soils of the terraces and kames; (5) soils of the first bottoms; and (6) miscellaneous soils and land types.

In the following pages the different soils are grouped according to their physiographic position and are described in detail, and their agricultural relations are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5.

[12] When a soil type is subdivided into phases, that part of the type that bears no phase name will be referred to as the normal phase of the type.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Sullivan County, N. Y.*

Soil type	Acres	Per-cent	Soil type	Acres	Per-cent
Lackawanna silt loam	45,056	7 1	Mansfield stony silt loam	768	0 1
Shallow phase	23,808	3 8	Tunkhannock gravelly loam	3,520	.6
Lackawanna stony silt loam	38,848	6 2	Alluvial-fan phase	192	(1)
Shallow phase	23,296	3 7	Tunkhannock loamy sand	1,792	3
Walton gravelly loam	23,360	3 7	Colchester loamy sand	4,032	6
Walton silt loam	18,816	3 0	Colchester gravelly loam	3,456	5
Walton stony loam	5,696	9	Chenango gravelly loam	2,560	4
Walton stony silt loam	3,712	6	Chenango gravelly sandy loam	1,664	3
Catskill loam	10,624	1 7	Otisville gravelly sandy loam	2,304	4
Catskill silt loam	5,184	8	Otisville gravelly loam	1,600	3
Catskill sandy loam	1,920	.3	Braceville silt loam	832	.1
Catskill stony loam	62,464	9 9	Barbour fine sandy loam	6,656	1 1
Catskill stony silt loam	17,920	2 8	High-bottom phase	704	1
Catskill stony sandy loam	2,624	4	Barbour silt loam	896	1
Liberty sandy loam	4,352	7	Barbour loamy sand	1,472	2
Liberty stony sandy loam	4,800	8	Gravel substratum phase	1,344	2
Dutchess silt loam	896	1	Barbour gravelly loam	768	1
Nassau shale loam	2,880	5	Alluvial-fan phase	1,088	2
Troy gravelly loam	1,600	3	Basher silt loam	1,216	2
Wellsboro silt loam	60,288	9 6	Holly silt loam	7,680	1 2
Wellsboro stony silt loam	23,744	3 8	Wallkill silt loam	64	(1)
Culvers silt loam	11,328	1 8	Rough mountainous land	40,320	6 4
Culvers stony silt loam	24,512	3 8	Rough stony land	27,840	4 4
Culvers loam	5,312	8	Smooth stony land (Catskill soil material)	4,480	7
Culvers stony loam	21,952	3 5	Alluvial soils, undifferentiated	11,328	1 8
Pittstown silt loam	320	1	Riverwash	576	1
Pittstown stony silt loam	256	(1)	Peat	7,360	1 2
Wurtsboro sandy loam	1,344	2			
Wurtsboro stony sandy loam	4,224	7			
Norwich silt loam	10,368	1 6	Total	631,040	100 0
Norwich stony silt loam	33,024	5 2			

[1] Less than 0.1 percent

WELL-DRAINED SOILS OF THE UPLANDS

The well-drained soils of the uplands are the most extensive soils of the county, occupying about 47 percent of the total area. Owing to their extent, they have played an important part in determining the type of agriculture practiced. They occupy the high, rough, and rolling parts of the county, where the relief ranges from that of undulating uplands and drumlins to the mountains in the northern and southern parts of the county. Good drainage is reflected in the light and uniform colors, which range from yellow to light red. Much of the area of the soils mapped in the Lackawanna, Walton, Catskill, and Liberty series is very stony and practically nonagricultural. The nonstony members of these series are the most important soils in the series because of their extensive area, suitable relief, and internal characteristics favorable to crop production. Besides the nonstony types mentioned above, this group includes members of the Dutchess, Troy, and Nassau series.

The Lackawanna series includes reddish-gray or dark reddish-gray acid soils. They are developed from parent materials derived from a comparatively thin mantle of glacial till composed of Indian-red sandstones and shales. The soils occur on the hilltops and hillsides of the deeply dissected plateau area of the county. The Lackawanna soils are characterized by their uniform gradation of color from a dark pinkish-gray surface soil to a deep Indian-red subsoil, good surface and internal drainage, and the compact subsoil. Many angular and subangular fragments of local sandstones and shale are scattered throughout the soil and over the surface. Variations within the series

are chiefly in depth and relief. Rock outcrops and a thin mantle occur in some areas, but generally the till reaches to a depth of 10 feet or more. The relief ranges from gently undulating on the hilltops to steeply sloping on the hillsides. Most of the steeper areas of these soils are forested and stony. The cleared areas are used for the production of silage corn, hay crops, and pasture grasses that contribute feed for dairy cows, as well as oats, potatoes, and other vegetables. The ease of maintaining good tilth, together with good drainage, makes the soils well suited to the production of these crops.

Two types, Lackawanna silt loam and Lackawanna stony silt loam, are included in this series. Lackawanna silt loam supports most of the agriculture. Lackawanna stony silt loam is mostly in forest. Shallow phases of each of these soils are also found. Lackawanna silt loam, shallow phase, is used mainly for pasture, and Lackawanna stony silt loam, shallow phase, is used mainly for forestry.

The Walton series includes reddish-gray, pinkish-brown, or purplish-brown acid soils. They have developed from parent materials derived from deep deposits of valley fill, glacial till composed of Indian-red, gray, and brown sandstones and shales. These soils occur generally in an intermediate position between the soils of the stream bottoms and the other soils of the uplands. Distinguishing characteristics of these soils are a uniform gradation of color from a brown surface soil to a deep reddish-brown subsoil, good surface and internal drainage, and a compact hardpan in the subsoil. The Walton soils differ from the Lackawanna not only in position along the sides of valleys and the more compact nature of the subsoil and depth of the soil mantle, but also in the presence of more rounded rocks and gravel throughout and more materials foreign to the area. Most areas of these soils are smoothly rolling, although a few are strongly rolling to steep.

These soils are well adapted to general farming in connection with dairy farming. The comparatively heavy texture of the soils, together with good drainage, makes them well suited to such crops as corn, oats, forage crops, and hay, and to pasture grasses.

Walton gravelly loam is the most extensive type in this series. Walton silt loam, Walton stony silt loam, and Walton stony loam are also recognized.

The nonstony types of the Walton series are the most productive soils of the uplands. Where properly managed, the highest yields of most crops may be obtained on these soils. The usual rotation followed on these soils is a 5-year one of corn (1 year), oats (1 year), and hay (3 years). Superphosphate and manure are applied on the cornland, and lime is applied with the seeding on the oats. From 400 to 600 pounds an acre of 16- or 20-percent superphosphate is applied. The average farmer applies about 10 loads of manure—roughly 10 tons an acre. The better farmers use heavier applications, especially of phosphate. A few farmers are using 250 to 350 pounds of 32-percent superphosphate. Ground limestone is applied at the rate of 1 to 1½ tons. Heavier applications than 1 ton to the acre would seem advisable on some areas of both the Walton and the Lackawanna soils, especially where longer rotations are used. A few farmers follow longer rotations and after the second season top-dress their meadows with manure in order to maintain better hay stands. Under

the present systems of management, erosion is not a serious problem in most places. The steeper slopes are generally in pastures. Little attempt is made to cultivate these steeper areas except to reseed pastures. On many of the so-called permanent pastures, pasture improvements and more regulated grazing would seem advisable to prevent erosion where it is a problem. In most of the pastures Kentucky bluegrass, redtop, colonial bent (Rhode Island bent), timothy, and wild white clover are represented in the grass cover. Pasture treatments as recommended for pastures on Lackawanna stony silt loam are applicable to pastures on this soil.

The Catskill series includes dark brownish-gray to brownish-gray acid soils. They are developed from parent materials derived from a comparatively thin mantle of glacial till composed of gray coarse-grained sandstone mixed with a certain amount of red shale. These soils occur on the hilltops and hillsides of the plateau area. The Catskill soils are characterized by a brownish-gray surface soil, a yellowish-brown upper subsoil layer, which grades into a gray to pinkish-gray lower subsoil layer, and good surface and internal drainage. The subsoil is compact. The gray color of the deep subsoil is derived from the parent material and is not due to unfavorable internal drainage conditions. Many angular and partly rounded fragments of the local and underlying sandstone are scattered over the surface and through the soil. Variations within the series are chiefly in depth and relief. The heavier textured or silt loam type seems to contain more red shale and has a more ruddy color than the other members of the series. Rock outcrops and a thin mantle of till are not uncommon in some areas, whereas in most places the depth of the till ranges from 3 to 8 feet or more. The relief ranges from gently rolling on the hilltops to steeply sloping on the hillsides.

Approximately 84 percent of the area of the Catskill soils is stony and for the most part remains in forest, although some of the stony areas have been cleared of woods and are used for pasture. A few of the gently sloping and less rugged areas of the Catskill soils are cleared of woods and stones and used in the production of silage corn, hay, and pasture grasses—crops essential to the support of the dairy cows.

The largest areas of the Catskill soils are in the southern part of the county. Small areas are scattered throughout the northern and eastern parts. Six types are included in this series, namely, Catskill loam, Catskill silt loam, Catskill sandy loam, Catskill stony loam, Catskill stony silt loam, and Catskill stony sandy loam. The most extensive soil in this series, Catskill stony loam, occurs in large areas southeast and southwest of Monticello.

Although some of these soils occur in Delaware County, they are included on the soil map of that county with the Culvers series; but since these soils are well drained, they are now separated from those of the Culvers series, which, as now defined, includes only imperfectly drained soils.

The Liberty soils, which are closely associated with the Catskill soils, include gray or brownish-gray acid soils. They have developed from parent materials derived from deep valley deposits of glacial till composed of approximately 80 percent gray sandstone and an admixture of local red shale and other gravel foreign to this area.

Like the Walton soils, they occupy a valley-fill position between the soils of the stream bottoms and those of the uplands, but they are more closely associated with the Catskill and Culvers soils. The Liberty soils differ from the Catskill not only in position but also in the depth of the soil mantle, a more compact subsoil, and the presence of more glacial rounded gravel, stones, and other material exotic to the area. The relief is rolling to strongly rolling and in a few places steep. Internal and surface drainage are good. The characterisitic gray color of the subsoil is inherited from the parent material and is not due to unfavorable drainage conditions.

Although the area occupied by the Liberty soils is not large, about 40 percent is used in the production of crops in support of dairying—corn, oats, forage crops, hay, and pasture grasses. The light texture of the soils, high acidity, and apparent lack of phosphates makes the inherent productivity somewhat lower than that of the Walton soils, which these soils resemble closely in relief, position, and other characteristics. The steeper areas of this soil series either are pastured or remain in forest. Two types, Liberty sandy loam and Liberty stony sandy loam, are recognized in this series.

The soils of the Shawangunk Mountains and of the southeastern slope of this range, including those of the Dutchess, Nassau, and Troy series, are distinctly different from the other soils of the county. They comprise an area of about 30 square miles in the southeastern corner of Sullivan County. The soils mapped in this area are closely associated with each other but are not associated with the other soils northwest of this range. Although the area of any one series in this district is small, larger units occur in the adjacent Orange and Ulster Counties. Lying so close to the Shawangunk Mountains, these soils contain quartz conglomerate intermixed in the glacial parent material in greater quantity than is typical in most of the series in which they are grouped. This quartz conglomerate, with which the Shawangunk Mountains are capped, is not intermixed with the till soils in sufficient abundance, however, to necessitate new series separations of the till soils on the eastern slopes.

The Dutchess series includes a yellowish-brown to brown acid soil. It has developed from parent materials derived from a medium-deep till composed mostly of slates and shales with an admixture of some quartz conglomerate and sandstone. Only one type, Dutchess silt loam, is mapped. It occurs in small areas on the slopes of the Shawangunk Mountains, which are capped by white quartz conglomerate, and a considerable quantity of this rock material is mixed through the soils of the vicinity. The Dutchess soil is characterized by a brownish-gray surface soil, a yellowish-brown friable upper subsoil layer overlying a moderately firm to compact brownish-gray lower subsoil layer, and an acid reaction. Scattered throughout the soil and over the surface are many shale fragments and partly rounded glacial pebbles. The relief is rolling to steep. Both internal and surface drainage are good. Variations within the series are chiefly in the depth to bedrock, which ranges from 2 to 6 feet. Approximately 90 percent of this land is cleared and used in the production of corn, oats, hay, and pasture grasses.

The Nassau series includes a shallow brownish-gray acid soil developed on a thin layer of glacial till and residual material from

slates and shales. Only one type, Nassau shale loam, is mapped in this series. It is associated with the Dutchess soil on the hillsides of the Shawangunk Mountains. The Nassau soil is characterized by a brownish-gray surface soil and a yellowish-brown friable subsoil, which overlies olive-gray shales and slates. Small shale fragments are numerous throughout. Variations within the series are principally in depth and relief, but these soils are everywhere shallow. The relief ranges from gently undulating to steep. Although not extensive in Sullivan County, the Nassau soil has been cleared in the past and used for farming.

The Troy series includes a brownish-gray soil having acid surface soil but neutral or slightly alkaline subsoil. It is developed from parent material derived from deep deposits of glacial till composed of shale, sandstones (some of which are calcareous), quartzite, and limestone. This soil series occurs in the valley on low, somewhat oval-shaped hills in the southeastern part of the county. The Troy soil is characterized by a brownish-gray surface soil, a friable yellowish-brown upper subsoil layer, a pale brownish-gray compact lower subsoil layer, and good surface and internal drainage. The Troy soil differs from the Dutchess soil, with which it is rather closely associated in this county, not only in the depth of the soil, parent materials, and the more compact nature of the subsoil, but also in the slightly alkaline nature of the subsoil and in relief. The relief is undulating to rolling. Troy gravelly loam is the only member of the series mapped.

Lackawanna silt loam.—This is one of the most important agricultural soils of the uplands. It is suited to the production of all the crops commonly raised in the county. It is most intensively developed in the central and western parts of the county. The soils are developed on the ridge tops and upper slopes of the plateau area.

The surface soil to a depth of 8 or 10 inches is reddish-gray to dark reddish-gray silt loam, mellow and generally matted with plant roots. The soil contains a fair quantity of organic matter as evidenced by the somewhat dark color of the surface soil. Beneath the surface layer is an Indian-red or weak reddish-brown mellow silt loam, which extends to a depth of 20 inches. Below this layer and extending to a depth of 32 inches the material is reddish-brown to weak reddish-brown firm to slightly compact gritty silt loam. Weak-red, very compact, heavy loam underlies this material and extends to a depth of 48 inches or to bedrock. This compact lower subsoil layer has a somewhat platy structure, and the individual plates are brittle. Fragments of red shale and sandstone are numerous in this layer. The reaction is acid throughout and many smaller fragments of shale occur in each layer and on the surface. Depth to the red shale bedrock averages about 48 inches, but it ranges from 3 to 6 feet or more. There are a few rock outcrops in some of the large areas.

In many areas where soils occur in close association with the Catskill and Culvers soils the Lackawanna are less red, as the parent material has been mixed with gray sandstone and shale. Here, the texture throughout the lower layers in such instances is also often more sandy. Where the parent material of these soils consists almost entirely of red shale with little admixture of red or gray sandstone, the

subsoils are a heavier silt loam and the color of the compact deep subsoil layer is distinctly grayish red.

Lackawanna silt loam occurs chiefly in Bethel, Cochecton, Liberty, Callicoon, and Tusten, but scattered areas are mapped in every town. The total area is 70.4 square miles.

The relief ranges from undulating to steeply sloping. Although a few areas are too steep for cultivation, they are not delineated separately on the map, but they can be readily distinguished on the map by the closeness of contours on the topographic base map. Most of the areas, however, have a gently undulating or sloping relief that is favorable to cultivation. Surface and internal drainage of these soils are good.

Most Lackawanna silt loam is intensively cultivated, and probably less than 5 percent of the area of the soil is idle or remains in forest. The soil is well suited to the production of red, Ladino, and alsike clover, timothy, oats, barley, buckwheat, millet, and pasture grasses. Alfalfa is productive in meadow seedings, although it is seldom seeded alone. Most of the crops are grown to support dairying, but a few areas are used for potatoes, cauliflower, and other vegetables. This soil has good structure and is easily tilled. Even though it is not inherently very fertile, it is responsive to management and produces higher yields of most crops when properly fertilized on dairy farms than most of the other soils of the uplands. It is considered a good soil for general crops. Corn yields from 40 to 50 bushels of grain an acre and 10 to 15 tons of silage, oats 40 to 50 bushels, wheat 15 to 20 bushels, timothy and clover hay 1½ to 2 tons, sweetclover 1½ to 2 tons, alfalfa 2 to 2½ tons, potatoes 175 to 250 bushels, and cauliflower 300 to 325 crates. About 25 percent of this land is pastured, 40 percent is in hay crops, 15 percent is in corn, 10 percent is in small grains, and 10 percent is used for vegetables and miscellaneous purposes.

Nearly all of the farms on the arable land of the county are operated as dairy farms and a considerable quantity of manure is available for use on crops. In addition to manure, many farmers apply superphosphate and lime. The average application is 1 ton of lime and 400 pounds of superphosphate, but the better farmers use somewhat higher applications of both lime and phosphate. With proper management, Lackawanna silt loam is one of the best soils in the county and certainly one of the most desirable soils of the uplands.

Throughout the county a 5-year rotation is commonly followed on Lackawanna silt loam. It consists of corn, oats, generally seeded with timothy and clover, and hay for 3 years. From 400 to 600 pounds an acre of 16-percent superphosphate together with about 10 tons of manure is applied on cornland. Lime is applied on the seeding at the rate of 1 ton of ground limestone to the acre. In most places erosion is only moderate, and on the average farm it is not a serious problem. Cultivated crops are generally worked across the slope but not necessarily on the contour. On some of the steeper slopes erosion is sometimes more severe. On such areas strip cropping and cultivation on the contour would be more practical. Many of the fields are so laid out and surrounded by large stone walls that such methods are impossible at present. Long narrow fields of 10 or 15 acres surrounded by wide stone walls are common throughout many areas of this soil and other Lackawanna soils.

Most of the cauliflower produced in the county is grown on this soil, and the rest is grown mainly on the Walton soils. It is a rather specialized crop, and fertilizer treatments for it vary from those of the general rotation. Though the acreage is small, it has been increasing in recent years. Cauliflower is a cool-season crop, is sensitive to unfavorable climatic conditions, and requires a liberal amount of rainfall. Climatic conditions are normally favorable for the growth of cauliflower and other cool-season crops in the northern part of this county. Like the Walton soil, this soil has a compact subsoil, not too rapid internal drainage, and sufficient slope so that excess water drains readily from the surface, all of which are favorable for cauliflower (*5*). Lime must be added in order to correct the acidity of these soils and make the reaction about neutral, as cauliflower does not thrive on the extremely acid soil. Hydrated lime is most commonly used. In order that the lime may be well mixed with the soil, it is best to plow the land and apply lime for the crop grown the year before the cauliflower. This practice also allows the sod to decay thoroughly. Superphosphate is applied at the rate of 1,200 to 2,000 pounds an acre, and commercial fertilizer (4–8–7 or 5–8–7),[13] varying in quantity up to 4,000 pounds, depending on the quantity of manure applied. Because cauliflower is a highly specialized crop, consultation with the county agricultural agent is usually advisable.

Lackawanna silt loam, shallow phase.—Many areas of Lackawanna silt loam in which the soil is shallow over the local bedrock are shown as a shallow phase where the size of the areas warrants such separation. The shallow soil generally occurs on the ridges and steep slopes. Areas of the shallow soil are somewhat less productive than areas of the normal soil. Fully 85 percent of the area is cleared while the rest is either forested or idle.

The surface soil of this phase to a depth of 8 inches is reddish-gray to dark reddish-gray friable silt loam. It is underlain by lighter red friable shaly silt loam to a depth of 14 inches. Below this is a firm heavy silt loam having an irregular fragmental structure. At a depth of about 20 inches there is a thin layer, not more than 2 or 3 inches thick, of disintegrating shale fragments just above the underlying bedrock. The depth of this soil averages about 20 inches; it ranges from almost nothing to as much as 36 inches. In places bedrock outcrops. The relief ranges from gently sloping to steep.

This soil occurs in scattered areas on the red shales, principally in the central and western parts of the county. A few areas included in this phase are steeper than normal, as may be detected on the soil map. They are indicated by the closeness or density of the contour lines. The largest areas are west of the Mongaup River in the west-central part of the county. In all, the soil covers 37.2 square miles.

The principal use of the cleared land is for pasture. About 20 percent of the land is used for hay, 10 percent for corn or small grains, and 10 percent for potatoes. Locally these soils are spoken of as shell-rock soils and are considered good for growing potatoes. Yields of potatoes are, in general, lower than on Lackawanna silt loam, averaging between 125 and 175 bushels an acre. Only the deeper areas of this type are used for potatoes or cultivated crops. Corn for

[13] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

silage produces 8 to 10 tons an acre, oats 30 to 35 bushels, and clover and timothy about 1½ tons.

Pastures contain about the same grasses as those on the normal phase. Although climatic conditions are usually most favorable for pastures in this county, occasional summer seasons are unusually dry, when pastures on this soil phase suffer severely. In areas of shallower soil, pasture also suffers during the driest periods of the average summer. Many pastures are overgrazed during these dry periods when grazing should be more carefully regulated.

Some of this shallow soil is maintained in pasture year after year. The better pastures are treated with phosphate and lime when seeded. From 300 to 600 pounds of 20-percent superphosphate and 2,000 pounds of lime are applied per acre. The areas of shallower soil in pasture are top-dressed with manure. Additions of superphosphate and lime are made as needed after the pastures are established.

Somewhat longer rotations are followed on this soil than is common throughout the county, as the land remains in hay or pasture for longer periods. After a second season of mowing the meadows are top-dressed. If the stand is good, it is mowed for a season or so longer; if the stand is poor, it is pastured. Erosion is not a serious problem on this soil under present management. The steeper areas that are in pasture are most seriously eroded where the pastures have not been treated or have been overgrazed. Some of the pastured steep areas would be best forested.

Lackawanna stony silt loam.—This soil differs from Lackawanna silt loam chiefly in having a much rougher surface and a large content of stone. Very little of the land is cleared and used for agricultural purposes. Where small areas occur throughout farming areas, these soils are usually used for farm wood lots or pasture. The larger areas are forested. Lackawanna stony silt loam occurs in small areas, mostly on steep slopes in the main agricultural districts of the county, and in large units in the northern and southwestern parts.

In forested areas Lackawanna stony silt loam has a 5-inch surface soil of brownish-gray or dark reddish-gray friable silt loam. The upper subsoil layer consists of Indian-red (weak-red) crumbly silt loam containing some small shale fragments and stone. Between depths of 14 and 22 inches the subsoil is weak-red silt loam that is firmer than the material in the horizon above and becomes increasingly compact with depth. Below this the subsoil becomes very distinctly compact and is weak-red heavy silt loam. This material breaks into irregular fragments that are hard and vesicular. This very compact horizon extends to a depth of 54 inches or to bedrock. Many angular or blocky stones and boulders occur throughout the soil and on the surface. The soil is acid and well drained.

The larger areas in the northern part of the county east of Long Eddy and in the vicinity of Livingston Manor are steep and the relief is unfavorable for agriculture. Although the relief of many of the larger areas in Tusten, Cochecton, and Highland is favorable to agriculture, these areas are forested. As most of these areas are owned by hunting clubs, scout organizations, the light and power company, and private estates, it is doubtful whether this land will be put to other uses than forest. About 60.7 square miles is mapped.

Perhaps about 10 percent of the land could be used more profitably for farming purposes if cleared of stones and trees. Most of it, probably more than 80 percent, supports a forest growth composed of maple, beech, birch, oak, white pine, and pitch pine. The few areas that have been more or less cleared of trees are used for pasture, but most of them are so stony that no pasture improvement practices are followed and only fair pasturage is obtained. Where many of the smaller stones are picked off and the pastures are treated with lime and superphosphate, better pasture grasses soon crowd out many of the undesirable ones and the stock-carrying capacity is increased considerably.

On many dairy farms where this is the only land available for pasture, large acreages of low productivity are grazed. The better areas of much of this pasture land could be improved, and much of the rougher less productive land should be returned to forest. The first essential in improvement is the removal of many of the stones on the better grazing areas. That these soils are low in phosphorus and lime and respond readily to treatment has been proved on these same soils in adjoining Delaware County (*5*). In most of the pastures wild white clover and Kentucky bluegrass grow naturally but represent only a part of the grass cover. The application of 500 to 800 pounds of 16-percent superphosphate and 1 to 1½ tons of limestone would provide more favorable conditions for the growth of desirable pasture grasses and especially the wild white clover. The encouragement of the wild white clover is essential, as this plant, like other legumes, increases the nitrates essential in the soils and eliminates the necessity of adding costly nitrogenous fertilizers. Application of phosphates every 3 years is desirable, and lime need not be applied as often unless a soil test indicates the need. It would be more economical to apply these practices to smaller areas of the nonstony soil of this series; nevertheless on many farms this stony land is the only land available for pasture.

Lackawanna stony silt loam, shallow phase.—This phase occurs in close association with the other soils of this series, but it is of little agricultural value and nearly all of it is under forest cover. It is shallower than Lackawanna stony silt loam, and rock outcrops are numerous throughout. The larger areas are in the southern half of Bethel and in the west-central part of the county. Small scattered areas occur throughout the areas of red shale in the county.

The surface soil is dark brown, is about 5 inches deep, and contains many small fragments of red shale and sandstone. The upper subsoil layer is brownish-red or weak-red friable silt loam containing fragments of red shale and sandstone. Between depths of 9 and 20 inches the material is weak-red rather firm or slightly compact silt loam that breaks into irregular fragmental aggregates. Just below this lowest layer and above the unweathered bedrock is a layer ranging from less than 1 inch to 4 inches in thickness, of disintegrating red shale weathered from the underlying bedrock. Throughout the soil there are many flaggy fragments, angular stones, and small boulders of red shale and sandstone. This soil varies considerably in depth, and outcrops of bedrock are numerous.

The soil occurs on the ridge tops and steep slopes, and the relief varies according to topographic position. The largest areas in the western part of the county and southwest of White Lake are forested.

Very few areas are cleared, and those that are furnish only fair pasture. Because of excessive stoniness and shallowness, this soil is not adapted to cultivation and is best used for forest. The forest vegetation consists principally of hardwoods and a few scattered softwoods. The principal trees are beech, birch, and maple, red oak, white oak, chestnut oak, and to some extent white pine and pitch pine. The undergrowth consists mostly of sweetfern and huckleberries. Where the land is forested, there is little evidence of erosion, but on many pastured steep areas erosion is severe. The aggregate area of this soil is 36.4 square miles.

Walton gravelly loam.—Owing to its characteristic position along valley slopes and on drumloid hills, Walton gravelly loam lies admirably as farm land and is favorable to rather full development as an agricultural soil. Nearly all of the land is tillable or potentially tillable; but a few areas, most of them on steep slopes, are reserved for permanent pasture. These soils are well suited to the crops grown in connection with dairy farming.

The surface soil is reddish-gray and friable and contains some angular and rounded glacial gravel. Between depths of 9 and 16 inches the material is light brownish-gray gravelly friable and structureless silt loam. This layer has a slight pinkish cast. The next lower layer consists of reddish-gray silt loam that is firm to slightly compact, has a thin platy structure, and is more gritty than the material above. At a depth of 24 inches the subsoil is a definitely compact weak-red gritty silt loam having an irregular fragmental structure. This layer extends to a depth of 48 inches. Below this the deep subsoil is very compact weak-red silt loam having an irregular fragmental and vesicular structure.

This soil is developed from deep glacial till deposits generally occurring in valley-fill positions. Rounded glacial boulders are numerous throughout. Although the subsoil is compact, internal drainage is good and surface runoff is rapid. The relief is rolling to steep. Few areas are too steep for cultivation, and these, although cleared, are generally in pasture. These areas are generally well indicated by the closeness of contour lines on the soil map.

Walton gravelly loam occurs chiefly in the central part of the county, especially within an east-west belt. Smaller areas are scattered throughout that part of the plateau area underlain by red shale. It is the most extensive soil of the series and covers 36.5 square miles.

Areas of Walton gravelly loam lie near valley roads, and many farmsteads are on or near them. This land is most intensively farmed, and probably less than 5 percent of it is in forest. About 20 percent is in permanent pastures, which are generally on the steeper areas. The remaining 75 percent is used in regular rotation in the production of crops in support of the dairying and for the production of vegetables in a few areas. The soils seem well suited to the production of red, Ladino, and alsike clover, timothy, oats, wheat, barley, buckwheat, millet, and cauliflower. This soil has good structure, is easily tilled, and, when properly fertilized, ranks with Walton silt loam as probably the most productive of the upland soils. Corn yields 45 to 55 bushels of grain an acre and 12 to 16 tons of silage, wheat 15 to 20 bushels, oats 40 to 50 bushels, timothy 1½ to 2 tons, timothy and clover 2 to 2½ tons, alfalfa 2 to 2½ tons, potatoes 175 to 200 bushels, and cauliflower 300 to 330 crates. About 40 percent of the land is in hay crops, 15

percent in corn, and 15 percent in small grains; 5 percent is used for vegetables and miscellaneous purposes.

Vegetables are grown on this soil as on the Lackawanna soils. Many of the growers use commercial fertilizers in addition to manures for these crops. Fertilizers of fairly high analysis are used, the commonest being 5–8–7. The quantity varies according to the quantity of manure applied and ranges from 300 to 1,200 pounds an acre. Where cauliflower is raised the same treatments are applied as on Lackawanna silt loam. The average lime requirements may be slightly lower on the Walton soil. The principal vegetables grown are sweet corn, potatoes, spinach, beets, carrots, tomatoes, and onions. A few growers also raise lettuce, cabbage, asparagus, and peas. The acreage of all vegetables grown, though small, is increasing. Many of the crops are marketed to the local hotels.

Walton silt loam.—This soil occurs chiefly in Liberty, Bethel, Callicoon, and Delaware. Some areas are scattered throughout that part of the county underlain by red shale. Like Walton gravelly loam, this soil occurs near or adjacent to the valley highways and intensively developed agricultural soils. Walton silt loam is less gravelly than Walton gravelly loam and in general is more red. It is perhaps slightly more productive than the gravelly soil.

The surface soil to a depth of 7 inches is brown structureless silt loam containing some glacial rounded and subangular gravel. The upper subsoil layer is very light reddish-brown silt loam that is friable and has a small irregular fragmental structure. Between depths of 15 and 26 inches the subsoil is distinctly reddish brown and firm to slightly compact. This layer has an irregular fragmental structure and breaks into small irregular aggregates. Below this the subsoil is grayish-red very compact silt loam that has an irregular fragmental-vesicular structure and is rather brittle when broken out. Beginning at a depth of 42 inches and extending to a depth of several feet, the subsoil, though compact, is more friable than it is above, consisting of pale reddish-gray or reddish-gray gritty silt loam boulder till. Many shale and round gravel fragments and boulders of varying sizes are present throughout. Internal drainage is good, and excess water drains readily from the surface, owing to the rolling relief.

On the average, the slope is somewhat steeper than that of the Walton gravelly loam. Areas in the vicinity of North Branch, Callicoon Center and Jeffersonville are especially steep. Because of this steeper relief more of this type is used for pasture. This soil is more closely associated than others of the series with soils underlain by red shale, and very few areas are scattered throughout areas underlain by gray sandstone areas. About 29.4 square miles is mapped.

Walton silt loam is used as intensively as Walton gravelly loam for agricultural purposes. It has about the same uses and requires much the same treatments for crops. About 25 percent of the land, however, is pastured, 5 percent is idle or forested, 37 percent is in hay, 14 percent is in corn, 14 percent is in grain, and 5 percent is used for vegetables and miscellaneous crops. Yields reported by farmers on this soil average slightly higher than those obtained on any other soils of the uplands. Corn produces about 50 to 55 bushels of grain and 14 to 18 tons of silage to the acre, wheat 15 to 20 bushels, timothy

1¾ to 2 tons, timothy and clover 2¼ to 2½ tons, alfalfa 2½ to 3 tons, potatoes 150 to 200 bushels, and cauliflower 310 to 350 crates. Buckwheat, which is raised as a late crop on most of the cultivated soils, returns 20 to 25 bushels.

The methods of management are much the same as those followed on Walton gravelly loam and Lackawanna silt loam. Although under the present systems of management erosion is not a serious problem, sheet erosion has been severe on a few areas. One such area is north of Jeffersonville; another is at Hunts Corner near Narrowsburg. Where erosion is a problem, strip cropping can usually be practiced, as the soil occurs on rather long slopes. The steeper areas of this soil are usually pastured and support good pasturage.

Walton stony loam.—This soil is not extensive. It differs from Walton gravelly loam in that the stones have not been removed from the surface and a few areas have not been cleared of forest. Its principal use is for forest or pasture.

The profile of this soil is similar to that of Walton gravelly loam. It differs principally in the surface layers under forest conditions. Beneath the matted litter of beech, birch, and maple leaves is a layer of very dark gray or almost black granular loam, about 2 inches thick. Beneath this and extending to a depth of 9 inches the material is light reddish-gray gravelly loam having a somewhat flaky structure. Between depths of 9 and 16 inches the dark yellowish-brown silt loam is friable and has a small soft irregular fragmental structure. Below this the subsoil is pinkish-brown slightly compact gritty silt loam having an irregular fragmental structure. When broken out, the fragments are somewhat platy. The lowest layer of the subsoil is reddish-gray very compact gritty silt loam. It has an irregular fragmental structure, which with depth becomes more vesicular. Glacial rounded and subangular boulders are scattered throughout the soil and over the surface. These boulders range from small and light ones to large ones weighing several hundred pounds. The stones on the surface are generally present in sufficient abundance to prevent cultivation of the land.

The soil is rather uniform and varies little except in color. In the southwestern part of the county, where most of the other soils are developed from gray sandstones, are areas of Walton stony silt loam, in which the color is lighter throughout than is normal, being strongly influenced by the underlying materials of the district. On the average, the slope is steeper than that of the nonstony soils.

The largest area of this type is north of Yulan, in the southwestern part of the county; and several small areas are scattered throughout the county along the valley slopes in districts where the bedrock is red shale. The aggregate area of Walton stony loam totals 8.9 square miles.

The forest trees include beech, black birch, red maple, sugar maple, aspen or popple, white pine, red oak, white oak, and black oak. The smaller undergrowth includes sweetfern, huckleberry, and mountain-laurel. About 65 percent of the land is forested; the remaining 35 percent is pastured. Although it supports fair to good pasturage, many of the pastures could be improved. The improvements suggested for Lackawanna stony silt loam can well be applied to this soil.

Walton stony silt loam.—This soil differs from Walton silt loam chiefly in the greater number of stones and rock fragments strewn over the surface, and from Walton stony loam in texture and the more definitely red color. The presence of many large stones, ranging in size from flat slabs to large boulders weighing several hundred pounds, make the land unsuitable for extensive improvement.

Beneath the leaf litter in forested areas is a 1- or 2-inch layer of very dark gray to black granular silt loam. Much of the decomposing leaf litter seems to be worked into this layer. Below this and reaching to a depth of about 8 inches is light purplish-gray friable silt loam containing fragments of red shale and stone. The next lower layer, which extends to a depth of 18 inches, consists of light reddish-brown friable silt loam that breaks into small, soft, irregular fragments. Below this the subsoil is Indian-red or grayish-red firm to slightly compact silt loam having an irregular fragmental structure and reaching to a depth of 25 inches. The deepest subsoil layer is very compact and grayish-red light silt loam that is more gritty than the overlying material. It breaks into irregular vesicular fragments that are rather hard and large. Rounded glacial boulders and subangular slabs of red shales and sandstones are numerous throughout.

This soil is rather uniform and varies but little. Most areas are steep, although a few are more gently sloping. None are large. They are scattered mostly throughout the northern part of the county as valley fill, glacial till material along the lower slopes of the uplands. The total area is about 5.8 square miles.

About 85 percent of the land is forested, and the rest is pastured. The forest vegetation is similar to that of Walton stony loam. Where cleared of forest and brush, this soil affords fair to good pasture.

Catskill loam.—This is the most extensive nonstony Catskill soil, and it is the most intensively farmed. Agriculturally this soil is not so productive as the other well-drained soils of the plateau area of the county, nor is it so intensively used. The deep-rooted birdsfoot trefoil is a good perennial legume for hay or pasture. Where properly managed, however, moderate or fair yields of the crops commonly grown in the county can be obtained.

The surface soil, about 8 inches deep, is dark brownish-gray rather heavy loam that is friable and has a fine crumb structure. The immediate subsoil to a depth of 15 inches is brown mellow light silt loam having no well-defined structure. Between depths of 15 and 25 inches the subsoil is yellowish-brown friable massive silt loam that is firm in place. The deepest subsoil layer below this is light olive-gray very compact sandy loam. It has a rather platy or irregular fragmental structure, and the fragments are brittle. The depth of this layer is variable throughout the area; on the average, however, it is about 48 inches. The underlying bedrock, a light olive-gray sandstone, is rather coarse-grained and acid. The entire soil contains many flaggy sandstone fragments, and in some areas small fragments are numerous on the surface. There are a few outcrops here and there.

The largest areas are scattered throughout the much larger areas of Catskill stony loam in the southern part of the county. Here, the soil is more typically developed and there is less intermixture of

parent materials foreign to the type. Areas are also scattered over the northern and eastern parts. The total area of this soil is 16.6 square miles.

The relief of Catskill loam ranges from smoothly rolling to sloping. The slope ranges from 3 to 12 percent in most areas, although a few areas are steeper and unsuited to cultivation. Most of the crops grown on this soil—corn, oats, timothy, and clover—are raised to support dairying. It is less fertile than the well-drained Lackawanna and Walton soils, and yields are somewhat lower. Corn yields from 35 to 45 bushels of grain and from 10 to 12 tons of silage to the acre, oats 40 to 50 bushels, and timothy and clover 1½ tons. From the few areas used for potatoes yields of 175 to 200 bushels are reported. Few other vegetables are grown except for home use.

The 5-year rotation commonly followed throughout the county is also followed on this soil, and, although the soil receives about the same treatment as other soils, it does not seem to respond over the rotation period so well as the reddish-gray soils. Having developed from a coarse-grained sandstone, it is, no doubt, inherently less fertile than those soils. Judging from the appearance of most meadows and pastures, the soil leaches more readily and is also more acid than the reddish-gray soils. Higher applications of lime in the rotations than the 1 ton an acre commonly applied would seem advisable, and in addition the meadows should be top-dressed with manure. Although very little mammoth clover is grown in the county, because it grows too rank and lodges on the better soils, this crop would probably be well adapted to this soil. There are some indications that Catskill loam is deficient in potash, although no experiments have been made to prove whether this is definitely so or not. About 15 percent of the land is in corn, 15 percent in grain, 45 percent in hay, 20 percent in pasture, and 5 percent is idle, forested, or given to other uses.

Pastures are only fair. They are composed mostly of Rhode Island bent, timothy, and redtop. They contain very little bluegrass or wild white clover, but contain several weed grasses, such as poverty oatgrass, and other weeds, such as devils-paintbrush, buttercup, yarrow, and ferns. Most of the pastures are not permanent, but after the meadows have been cut for 2 years they are then pastured. The meadows are often run down after 2 years, and where they are not top-dressed, they do not furnish good pasture over a period of years.

The soils are not seriously eroded, although there is evidence of slight to moderate sheet erosion in many places. This can be controlled by ordinary management practices and simple erosion control measures, including strip cropping and cultivation across the slopes.

Catskill silt loam.—Although not so extensive as Catskill loam, Catskill silt loam is a somewhat better soil for agriculture. It lies more closely associated with the areas underlain by red shale, and some of this material is mixed with the gray sandstone parent materials. The relief is favorable to cultivation, and most areas are farmed.

The 6-inch surface soil is dark brownish-gray silt loam. Under sod this material has a fine crumb structure and is mellow. The upper subsoil layer, which reaches to a depth of 18 inches, is ruddy-brown friable gravelly silt loam. Below this the subsoil is brown to dark-brown gritty silt loam that is firm in place but friable. This layer

has a light reddish-gray cast. Between a depth of 25 inches and bedrock, which lies about 54 inches below the surface, the deepest subsoil layer is gray compact sandy loam containing considerable gray sandstone gravel, stones, and slabs. Sufficient red sandstone and shale material is mixed in this material to give it a distinct reddish cast. Small fragments and flaggy pieces of sandstone are present throughout. Some fragments are also present on the surface, but generally not in sufficient quantity to interfere with cultivation. Catskill silt loam has the greatest variation in color of any of the types in this series. The slope is generally gentle, ranging from 3 to 15 percent in most areas. The few areas having a slope steeper than 15 percent are generally pastured.

Most areas of this soil are not large—from one-fourth to one-half of a square mile in size—and are scattered throughout the northern and northeastern parts of the county. Larger areas of the Catskill stony silt loam are generally associated with this soil. About 8.1 square miles is mapped.

Most of the crops commonly grown in the county are produced on this soil. It seems to have more body than Catskill loam, and it responds better to treatments applied in the rotation. Corn for grain yields 40 to 45 bushels and for silage 10 to 14 tons to the acre, oats 45 to 50 bushels, timothy and clover 1½ to 2 tons, and buckwheat 18 to 22 bushels. About 5 percent of the land is idle or reforested. In the northern part of the county areas of abandoned land have been bought up for the Catskill Forest Preserve or for private hunting preserves. A few areas of Catskill silt loam occur in this area and are now reforested or idle. About 5 percent of the land is pastured, 20 percent is in grain, 20 percent in corn, and 50 percent is in hay.

The usual 5-year rotation is followed, and the common treatments are applied to the soil. Sheet erosion is the greatest problem and is a little more severe on this soil than on Catskill loam. With the use of strip cropping on the longer slopes and cultivation on the contour, erosion can be controlled under ordinary practices.

Pastures are somewhat better on this type than on the Catskill loam, and the presence of wild white clover is generally noticeable. On the poorer pastures and idle land many weeds, sheep sorrel, yarrow, devils-paintbrush, cinquefoil, poverty oatgrass, dewberries, and goldenrod are also found. The better pastures include wild white clover, Rhode Island bent, timothy, and redtop.

Catskill sandy loam.—This soil is not extensive. It occurs mainly in the northeastern part of the county, north of Grahamsville, and the total area is only 3 square miles. The soil is developed from light olive-gray sandstone, as are the other Catskill soils, but the parent material seems to contain more sandstone conglomerate and the sandstone is coarser grained. The land is used principally for pasture or is idle.

The 7-inch surface layer of dark-gray loose sandy loam is underlain by yellowish-brown loose structureless friable loam about 5 inches thick. The next lower layer, about 3 inches thick, consists of brown friable structureless heavy loam. Between depths of 15 and 27 inches the subsoil is brownish-gray firm sandy loam. The deepest subsoil layer is gray very compact loamy sand that breaks into easily crushed irregular fragments. The reaction is acid throughout, and flaggy pieces and small fragments of sandstone are numerous. Bedrock lies at varying depths but generally between 3½ and 4 feet.

Most areas of Catskill sandy loam are rather steep and are not favorable for the use of farm machinery. Nearly all of the land is used for pasture, although under present management the pastures do not afford good grazing. A few areas are too steep even for grazing, and erosion could be more easily controlled if these areas were forested. One area especially, about half a mile north of Lowes Corners and east of Sugarloaf Brook, is now pastured, severely eroded, and very steep. About 5 percent of the land is cultivated, 10 percent is idle or reforested, and 85 percent is pastured. The pastures appear not to have received any treatments or particular management. Although they support some timothy and Rhode Island bent, noxious weeds and poverty oatgrass predominate. Sheet erosion on most of the pastures is rather severe, and a few shallow gullies have formed. If these soils are to be maintained in permanent pastures, reseeding with suitable pasture mixtures and treatments of lime and superphosphate are necessary. The soils are rather loose in the surface layers, and the addition of manure to the treatments would improve the organic condition of the soils.

Catskill stony loam.—This is the most extensive soil in the county. Large areas are mapped in the southern towns in the plateau areas, and smaller ones in the eastern and northern parts of the county. Nearly all of the land is forested and is owned by hunting clubs, camp organizations, and the light and power company.

Beneath the litter in forested areas the 8-inch surface soil is dark brownish-gray friable stony loam that is high in organic matter. The immediate subsoil is dusky or coffee-brown mellow and friable heavy loam. Between depths of 15 and 25 inches the subsoil is yellowish-brown slightly firmer friable silt loam. Below this the subsoil is compact light olive-gray sandy loam. It has an irregular fragmental, almost platy, structure. When the subsoils are wet they do not seem nearly so compact as when they are dry. Bedrock lies about 3½ feet below the surface in most of the areas; but many outcrops among these soils are not indicated, as in the nonstony types. In the soil and on the surface are many sandstone boulders and large angular rocks. The soil is strongly acid throughout.

The largest areas occur in Tusten, Highland, Lumberland, Forestburg, and Mamakating. A total area of 97.6 square miles is mapped. The relief ranges from undulating on ridge tops to steeply sloping. No attempt was made to separate the gentler from the steeper areas, as the soil is mostly forested and where not forested is pastured. Many areas included in this soil would be suitable for cultivation if cleared of trees and stones.

The forest growth on these soils is mostly hardwood (beech, black birch, yellow birch, red maple, sugar maple, red oak, white oak, and black oak), and a few softwoods (pitch pine, white pine, hemlock, and fir). In the southern part of the county more pitch pine, chestnut oak, and sassafras trees are mixed with the hardwoods. In the northern part of the county these trees are not present but there are some spruce, fir, and more white pine mixed with the hardwoods. In the southern part of the county there is also an abundance of scrub oak, which is very noticeable in contrast with the trees in the northern areas. On all areas that have been burned, aspen (popple) comes in abundantly. Chestnut must have been a dominant species in these forests at one time, as many dead trees are still standing and young sprouts are still

growing, although diseased. A few sprouts have reached fair size in this area and bear burs. Approximately 90 percent of the land is forested.

About 10 percent of the Catskill stony loam is pastured. Most of the pastures are large and receive little treatment or care. They support fair growth of bent, timothy, and redtop; but they contain very little bluegrass or wild white clover. Poverty oatgrass and other weeds are abundant, so that cattle in grazing have to select grasses carefully. On many farms, however, this is the best soil available for pasture. The large amount of pasture land on the average farm, in proportion to the livestock kept, is an indication of the low productivity of this soil. Improvement of the better adapted areas should make it possible to retire some of the more poorly adapted ones. Removal of flagstones and small stones alone would greatly improve many of the present pastures. On many of the better pastures this has already been done. Treatments with superphosphate at the rate of 400 or more pounds an acre and 1 to 1½ tons of lime are necessary for best results.

Catskill stony silt loam.—This soil, like Catskill silt loam, occurs in closer association with the reddish-gray soils than most other members of the series, and the mixture of red shale and sandstone materials is reflected in the color of the soil.

Under forest conditions the surface soil beneath the forest litter is dark-gray silt loam, about 4 inches deep. It contains considerable organic material, is finely granular, and is acid. Below this the material is dusky-brown or coffee-brown friable silt loam. Between depths of 14 and 20 inches the subsoil is weak-olive firm but friable gritty loam having a light reddish cast. The deep subsoil layer, which reaches to a depth of 40 inches, is gray compact sandy loam that breaks into brittle irregular fragments. This material has a light reddish-gray or pinkish cast. When thoroughly wet the soil is not so compact as when dry. The soil is acid throughout. Flagstones and large boulders are numerous in the soil and on the surface.

Areas of Catskill stony silt loam range from slightly sloping to steep. Several areas that are undulating to gently rolling would be suitable for cultivation if cleared of stone and trees. The largest area of this soil is around Mamakating Park, and many smaller areas are scattered throughout the county. The aggregate area is 28 square miles.

About 70 percent of the land is forested. The forests have all been cut over and consist of second-growth sugar maple, red maple, black birch, beech, basswood, black cherry, and, to some extent, hemlock and white pine. About 30 percent of the land is used for pasture. Pastures are fair, and the principal grasses are Rhode Island bent, timothy, and poverty oatgrass. Kentucky bluegrass and wild white clover, though present, are in few places so dense as desired in good pasture. Many noxious weeds and poverty oatgrass grow in the pastures. The stony condition of most pastures makes improvement difficult and pasturage scarce. Where this is the best land available for pasture on a farm, removal of stones and treatment of the pastures would greatly improve the pastures.

Catskill stony sandy loam.—This type differs from the Catskill sandy loam in that it is so stony that it cannot be feasibly cultivated.

It is much lighter textured than the other stony types in this series and is developed mostly from a coarse-grained conglomerate sandstone. Nearly all of the land is forested, and little is pastured.

The 6-inch surface soil of Catskill stony sandy loam is dark grayish brown beneath the matted forest litter. It is loose, friable, and structureless and contains a considerable quantity of organic material. This material is underlain to a depth of 15 inches by dark yellowish-brown structureless friable light loam. Below this the subsoil is brownish-gray sandy loam that is structureless and firm in place but friable. Beginning at a depth of 27 inches the deep subsoil is gray compact sandy loam. The reaction is acid throughout, and many flaggy sandstones and boulders are present. The relief ranges from gently sloping to steep.

This type is more localized than the other types of this series. The most typical areas of Catskill stony sandy loam are south of Denman Mountain. The total area is 4.1 square miles.

The forest cover is composed of beech, black birch, sugar maple, white pine, basswood, hickory, chestnut sprouts, and red and white oaks. All the forests are second growth and have been cut over several times. There is little erosion in forested areas, but pastures are moderately eroded in most areas. The pastures are poor in most instances, and the principal grasses are redtop, Rhode Island bent, and poverty oatgrass. The abundance of sandstone flagstones and rocks makes grazing sparse. The carrying capacity of the pasture is very low.

Liberty sandy loam.—This soil is not extensive in area. Owing to its valley position, its considerable depth, and its general nearness to farmsteads and valley soils, it is rather extensively developed. This soil and the stony Liberty soil bear the same relation to the Catskill soils as the Walton soils do to the Lackawanna. They occur in small areas along the valleys throughout the areas where the underlying rock is gray sandstone.

The surface soil of Liberty sandy loam is dark brownish-gray friable and structureless heavy sandy loam, about 6 inches deep. The surface texture is quite variable and in many places is light loam. The upper part of the subsoil is weak-brown mealy gravelly loam that is structureless and slightly heavier than the surface soil. Between depths of 16 and 27 inches the subsoil, though slightly compact, is friable gritty brownish-gray gravelly loam with a platy structure. The next lower layer, which reaches to a depth of 44 inches, is gray to brownish-gray very compact sandy loam. This material has a platy structure and contains considerable gravel and small angular gritty particles. The platy fragments are vesicular. The deepest subsoil layer below a depth of 44 inches consists of gray and brown loose single-grained sand and rounded gravel. Rounded glacial boulders and subangular rock fragments are present throughout. Over 80 percent of the gravel and rock fragments within the soil are composed of gray sandstone. The foreign materials include quartzite, red shale, sandstone, and some crystalline rocks.

Liberty sandy loam occurs mainly in the southern and eastern parts of the county, in association with Catskill loam and Catskill stony loam. The soils occupy an intermediate position between the soils

of the valley and the till soils of the uplands. In all, about 6.8 square miles is mapped.

Areas of this soil are rolling to steep. About 30 percent of the land is too steep for cultivation and remains in forest. Another 5 percent of the land is idle and has been abandoned principally because of its association with larger areas of poor agricultural land. The remaining area is cultivated and used in the production of crops commonly grown in the county. The lighter texture of this soil, together with high acidity, lowers the inherent fertility as compared with that of the Walton soils, which this soil resembles closely in relief, position, and other characteristics. Corn for silage yields 10 to 12 tons an acre, oats 40 to 45 bushels, timothy and clover hay 1½ to 1¾ tons, and mammoth clover 2 tons.

A 5-year rotation is followed on this soil as on the other soils of the county. Larger applications of superphosphates—500 to 700 pounds an acre—and heavier applications of manure are used on this soil than on the Walton soils. Although the soil is strongly acid, the use of only 1 ton of lime seems to be the common practice. Where these treatments are followed, fair yields of the common crops can be obtained. Erosion is not a serious problem on this soil, although the relief of the cultivated land is strongly rolling in some areas. Most of the cultivated crops are worked across the slope, and under such conditions sheet erosion is only slight to moderate. On the longer slopes, erosion can be controlled more efficiently by strip cropping.

Liberty stony sandy loam.—This inextensive soil occurs in the valleys and in association with the nonarable soils of the Catskill series. Most of the land is forested. A few areas would be suitable for cultivation if cleared of stone and trees.

Beneath the matted litter in forested areas the surface soil is very dark brownish-gray light loam or sandy loam, about 6 inches deep. The soil is loose, structureless, and well mixed with organic material. The upper subsoil layer is light-brown friable loam. Between depths of 14 and 26 inches the subsoil is slightly compact but friable gritty brownish-gray gravelly loam. This material has an irregular fragmental to platy structure. The next lower layer of the subsoil is gray to brownish-gray very compact sandy loam that breaks into medium-hard, rather brittle, irregular fragments. The fragments are vesicular and almost platy. Below a depth of 47 inches the deepest subsoil layer consists of gray and brown loose and structureless sand and gravel. This loose material in a few places is water-assorted; however, this assortment of materials is not typical. Large glacial boulders and angular rock fragments are throughout the soil and scattered over the surface. The stones are generally so abundant that cultivation is impossible. The rock and gravel materials are derived mostly from gray sandstone.

Liberty stony sandy loam occurs mostly in the southern part of the county along the Delaware River valley and the valleys of its tributaries. The largest area is in Tusten; other areas are southwest of Liberty, north of Fowlerville, and northwest of Wurtsboro. The total area is 7.5 square miles.

Most of the areas of this soil are strongly sloping to steep. About 80 percent of the land is too steep for cultivation, the slopes ranging

from 15 to 35 percent. Small areas have a more gentle slope; most of these areas are either inaccessible or in association with larger areas of other nonagricultural soils and therefore have not been cleared of stones or forest. Liberty stony sandy loam is principally forested. The forest growth consists of red, white, and scrub oaks, hickory, and sassafras mixed with other hardwoods and pine. Pitch pine and white pine are the important softwoods. Other important hardwoods present but in lesser number are sugar maple, red maple, black birch, yellow birch, and beech. The undergrowth is mostly huckleberries, sweetfern, and mountain-laurel.

Dutchess silt loam.—This soil occurs on the eastern slopes of the Shawangunk Mountains. Although the area is small, this is the most important soil developed from glacial till in this part of the county. It is intensively cultivated and produces good yields of most of the crops commonly raised in the county.

The surface soil is light brownish-gray silt loam that has a fine-crumb structure, is friable, and contains many small shale fragments. Below plow depth and extending to a depth of about 14 inches is yellow or light yellowish-brown silt loam that is friable and contains some rounded and subangular gravel and shale fragments. The next lower layer of the subsoil consists of light-brown slightly compact gravelly loam that has a fine nutlike structure and contains many shale fragments. Below a depth of 24 inches the deep subsoil layer is rather firm but friable light loam and contains many shale fragments of the underlying bedrock. Bedrock lies 44 inches below the surface. The soil is acid throughout and contains many large conglomerate rocks and other boulders. The depth to bedrock varies but averages about 4 feet. The relief is rolling to hilly, and the slope ranges from 8 to 15 percent.

The soil occurs in a narrow belt extending northeastward from the county line along the lower slopes of the Shawangunk Mountains. The total area is only 1.4 square miles. One small area about 1¼ miles west of Winterton and included in this type is too stony for cultivation and is forested. This area is indicated on the map by stone symbols.

Approximately 90 percent of the land is cleared and used for the production of corn, oats, hay, and pasture. About 20 percent is pastured, 15 percent is in corn, 15 percent is in small grains, and about 40 percent is in hay. Under present management the soil produces moderate to fair yields. Corn for silage yields 11 to 14 tons and for grain 50 to 60 bushels to the acre, oats 40 to 50 bushels, rye 25 to 30 bushels, and wheat 30 bushels. Alfalfa yields from 2 to 2½ tons, timothy and clover 1½ to 2 tons, sweetclover 1½ to 2 tons, and timothy 1½ to 1¾ tons. Potatoes yield about 150 bushels an acre. Oats are frequently cut green, and rye is sometimes grown for pasture.

The usual rotation is a 5- or 6-year one. One year of corn is followed by small grains seeded to hay crops, which are maintained 3 or 4 years in hay or pastured 1 or 2 years after 2 years of hay. From 10 to 12 tons of manure and 300 to 500 pounds of superphosphate to the acre are applied in preparing the land for corn. A ton or more of lime is applied for oats. Meadows that are kept in hay for 3 or 4

years are sometimes top-dressed with manure after the second or third season.

Pastures vary considerably on Dutchess silt loam. Most of the pastures, however, are fair to good. As these soils are rather intensively cultivated, there are no permanent pastures on them. The pastures are grazed 1 or 2 years of the regular rotation and are then plowed. Most of the pastures contain wild white clover, Kentucky bluegrass, Rhode Island bent, red clover, and timothy. The older pastures do support some poverty oatgrass, yarrow, ribwort (English plantain), sorrel, and pussytoes (ladystobacco).

The forested area supports a hardwood stand of beech, sugar maple, sassafras, white ash, red oak, and chestnut oak, tuliptree, and shagbark hickory. Chestnut sprouts of fair size in the woods surround the old dead chestnut trees.

Under the present management erosion is not a serious problem, as most of the cultivated crops—potatoes and corn—are worked across the slope. It is evident that some areas have suffered severe sheet erosion in the past. The lay of the land is suitable for strip cropping, and in some areas the adoption of strip cropping would be advisable where sheet erosion is moderate to severe.

Nassau shale loam.—This soil occurs on the eastern hilltops of the Shawangunk Mountains. It has a low agricultural value, and nearly all of the land is idle or forested. Only about 20 percent is pastured.

The surface soil is dark brownish-gray friable structureless shaly loam. In forested areas this material approaches silt loam in texture. Below plow depth, or a depth of about 7 inches, the subsoil is olive-gray shaly silt loam having a fine lumpy or irregular fragmental structure. Below a depth of 15 inches the subsoil consists of light olive-gray partly decomposed shale coated with yellowish brown. Bedrock or undecomposed shale occurs at a depth of about 26 inches. The reaction is acid throughout. In some places the soil is 30 inches deep, and in others the shale bedrock appears at the surface. The relief ranges from nearly level to strongly sloping.

The soil occupies a belt ranging in width from one-quarter to one-half of a mile and extending northeastward from the Sullivan-Orange County line along the slopes of the Shawangunk Mountains. The total area of this type is 4.5 square miles.

Although this land has been cleared in the past and used for farming, over 60 percent of it is now severely eroded and idle or is reverting to forest, 20 percent is forested, and 20 percent is pastured. The pastures are poor and neglected, and the carrying capacity is very low. The pastures contain very few good pasture grasses—timothy and Rhode Island bent mixed with about 80 percent poverty oatgrass, sheep sorrel, devils-paintbrush, goldenrod, wild strawberry, wild aster, and creeping cinquefoil. In the pastures and also in the idle land are encroachments of hawthorn (*Crataegus* sp.) and sumac. Sheet erosion is severe in the pastures and on the idle land. About 20 percent of this land has been abandoned for a long time and now supports a fair forest cover, sufficient to protect the soil from erosion. Although the forests contain many temporary undesirable tree species, such as aspen (popple), white birch, and wild cherry, better hardwood species—red oak, shagbark hickory, black cherry, and sugar maple—are

coming in to replace them. Reforestation of about 20 percent of the idle area has been done recently, and, although there has been some mortality, owing to drought and erosion, the ratio has been low and most plantations look promising. Red, white, and Scotch pines have been used for reforesting. Pure white pine plantations are more seriously troubled with weevil in this county than are mixed plantations; and, although these plantations as yet have not been attacked by weevil, a mixture of seedlings in future planting would seem advisable.

For the most part pastures are very poor on Nassau shale loam, and it is doubtful whether the increase in carrying capacity would justify the cost of improving them. To prevent continued erosion on these soils and damage to the better soils on the slopes below, reforestation of the pastured and idle areas of Nassau shale loam seems most advisable.

Troy gravelly loam.—This soil is not extensive, and about 60 percent of the total area is forested. The soil is closely associated with the Dutchess soil on the southeastern slopes of the Shawangunk Mountains. Though adapted to cultivation, only the areas in the vicinity of Bloomingburg and Winterton have been cleared of forest and used for this purpose.

The surface soil, about 10 inches deep, is dark brownish gray, is friable, and has a fine granular structure. The upper subsoil layer is light-brown or yellowish-brown loam that is firm but friable and has a flaky structure. Between depths of 19 and 29 inches the subsoil is slightly compact and has an irregular fragmental structure. Below this, there is a layer, about 11 inches thick, of light yellowish-brown rather loose sandy gravelly loam. This layer is not typical of soils of this series as mapped in other areas. Below a depth of 40 inches and extending to a depth of 10 or more feet, however, the deepest subsoil material is compact coarse gravelly sandy loam. Calcareous sandstone fragments are present throughout this layer. The reaction ranges from neutral to slightly alkaline. The soil contains a considerable quantity of shale material and boulders of sandstone and quartz conglomerate.

The soil is associated with the Dutchess soil but occupies more of a valley-fill position. It occurs as morainic deposits and has a drumloid relief. The slopes range from 8 to 15 percent. The soil occurs in scattered units west of the valley of Shawangunk Kill; the largest one is at Roosa Gap. The aggregate area is 2.5 square miles.

The forests on this type are mostly hardwoods. They have been cut over several times. The present stands are second-growth white ash, sugar maple, red maple, red oak, white oak, shagbark hickory, black locust, and basswood. The rate of growth seems to be very rapid for most species.

The cultivated land is intensively worked and used for the production of corn, oats, and wheat, and timothy, clover, and alfalfa hay, and pasture grasses. A 5- or 6-year rotation is practiced, of corn followed by a small grain (oats, wheat, or rye), seeded with hay (clover, timothy, or alfalfa, or mixtures of these plants) for 3 or 4 years. From 300 to 400 pounds of superphosphate is applied with 10 or 12 tons of manure on the corn. Lime is applied to the land prepared for the small grains and seedings at the rate of 1 to 1½ tons an acre.

On the soils of this type, which are a little lighter in surface texture near Winterton, light top dressings of manure are needed in many places for the hay crops after the second season. Sheet erosion on the corn crop is sometimes a problem where cultivation across the slope or with the contour is not closely followed. Although small rills develop, the soils are gullied in but few places. If cultivated crops are grown only once in 6 years, erosion is not a serious problem unless the soils are cultivated without attempting to work on the contour or across the slope. Corn yields from 12 to 15 tons of silage and 50 to 60 bushels of grain to the acre, oats 40 to 50 bushels, and rye and wheat about 35 bushels. Timothy and clover and timothy and alfalfa are the leading hay crops and yield from 1½ to 2 tons; alfalfa, though rarely seeded alone, yields 1½ to 2½ tons.

About 20 percent of the cultivated land is in corn, 15 percent is in grain, and the rest is in hay. When the hay has run out, the meadows are sometimes pastured for a season before plowing the land for corn.

IMPERFECTLY DRAINED SOILS OF THE UPLANDS

The imperfectly drained soils of the uplands are about half as extensive as the well-drained soils of the uplands. They occupy approximately 24 percent of the total area of the county. The comparatively large area of these soils and close association with the well-drained soils of the uplands have influenced the type of agriculture practiced. These imperfectly drained soils occur mostly in the plateau area in the less undulating areas and on the long gentle slopes. They occupy many of the smoother areas between the more undulating or steeper areas of well-drained soils and the flat or depressed areas of poorly drained soils. The imperfect drainage is reflected in the discoloration and strong mottling of the subsoils and to a certain extent in the vegetation. Approximately 45 percent of this land is stony, is not arable, and is either in forest or in pasture. The nonstony soils of this group are the most important and will produce most of the crops grown in the area. Yields on most of them, however, are somewhat lower than those of the associated well-drained soils. The relief of the long gentle slopes on which these soils occur is more favorable to the use of farm machinery than that of many of the associated well-drained soils. For this reason, and for the reason that the well-drained and imperfectly drained soils are so closely intermingled, the nonstony imperfectly drained soils are as intensively used as are the well-drained soils of the upland. Included in this group of imperfectly drained soils are stony and nonstony types of the Wellsboro, Culvers, Pittstown, and Wurtsboro series.

The Wellsboro series includes imperfectly drained acid soils developed from moderately deep compact glacial till composed of Indian-red, brown, and dusky-red shales and sandstones. The Wellsboro soils are the imperfectly drained associates of the Walton and Lackawanna soils. This series occurs on the hilltops and hillsides of the plateau area of the county. The soils are more or less tinted with red throughout. The upper part of the compact substratum and the subsoil immediately above this compact zone are mottled; the degree of mottling, however, varies considerably. Although external drainage is imperfect, surface drainage is good. Many angular and rounded fragments of glacial sandstone and shales are scattered

throughout the soil and over the surface. Variations within the series are chiefly in the degree of mottling and the color of the soil. Where the parent material has been diluted with an abundance of gray sandstone the red color is lighter and more of a reddish gray. The relief ranges from undulating to gently rolling. Of the imperfectly drained soils of the uplands, the Wellsboro soils are the most intensively utilized. Fully 70 percent of the area occupied by these soils has been cleared and is arable. These soils are used for the production of corn, oats, hay, and, in a few areas, vegetables, and they are also used for pasture. Fair yields are obtained from these soils in a normal season. Two types, Wellsboro silt loam and Wellsboro stony silt loam, are included in this series.

The Culvers series includes pale-brown to brownish-gray imperfectly drained acid soils. They are developed from moderately deep, compact glacial till composed of gray sandstone and some red shales. The Culvers soils are the imperfectly drained associates of the Catskill and Liberty soils and occur on the hilltops and gentler hillsides of the plateau area of the county. They have a light brownish-gray surface soil, a yellowish-brown upper subsoil layer that is strongly mottled in the lower part, and a compact mottled brownish-gray deep subsoil layer. The degree of mottling varies considerably within the series. Other variations are chiefly in the depth of the soil mantle and in the color of the soil. In places a mixture of some red shale in the parent materials imparts a pinkish cast throughout the soil. Although the soil mantle in this area is in general moderately deep, in some areas, especially of the stony types, rock outcrops are not uncommon. The relief is smooth to gently rolling. Although internal drainage is imperfect, surface drainage of these soils is generally good. Only about 28 percent of the soils of this series have been suitably cleared of stones and forest for cultivation. Moderate yields of the crops grown in support of dairying are obtained from these soils. Although most of this land is stony, from 30 to 40 percent of the stony land is pastured.

Four types, Culvers silt loam, Culvers stony silt loam, Culvers loam, and Culvers stony loam, are mapped.

The Pittstown series includes brownish-gray to weak-brown imperfectly drained acid soils developed from shale and sandstone materials. The soil materials were deposited as a moderately deep glacial till along the lower slopes of the Shawangunk Mountains. They are the imperfectly drained associates of the better drained Dutchess soil. The soils of the Pittstown series are characterized by a dingy yellowish-brown surface soil, a lighter yellowish-brown upper subsoil layer, and an olive-gray mottled compact deep subsoil layer. The relief ranges from gently to strongly sloping. These soils are also closely associated with the Wurtsboro soils and contain some Shawangunk conglomerate material in the profile. The percentage of conglomerate material, however, is generally less than 20 percent, and more than 80 percent is shale and sandstone. This mixture of conglomerate has taken place because these soils lie so close to the Shawangunk Mountains, but it is not typical of the Pittstown soils as mapped outside the county. Pittstown silt loam and Pittstown stony silt loam, which cover a small total area, are mapped.

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The Wurtsboro series includes pale-brown to light brownish-gray imperfectly drained acid soils. They are developed from quartzite, shale, and sandstone materials deposited as deep glacial till along the lower slopes of the Shawangunk Mountains. The Wurtsboro soils are characterized by a light brownish-gray surface soil, a yellowish-brown upper subsoil layer, and a weak-brown compact deep subsoil. The subsoil immediately above the compact substratum and the upper few inches of the compact substratum are strongly mottled. Many large stones and small boulders are scattered throughout the soil. The relief is rolling to steep. The soils of the Wurtsboro series are localized soils in that they are developed almost entirely from a quartzite conglomerate common to the Shawangunk Mountains. Wurtsboro sandy loam and Wurtsboro stony sandy loam are recognized in this series. Only a small area of these soils is pastured or cultivated.

Wellsboro silt loam.—This is the most extensive and the most intensively developed of the imperfectly drained soils of the uplands. It is closely associated and intermingled with the Lackawanna and Walton soils. The slope is more gentle than that of the Lackawanna and Walton soils. The soil is moderately productive, and many prosperous farms are operated on it and the associated soils. Locally this soil and Wellsboro stony silt loam are considered warmer than the other imperfectly drained soils, as these soils usually dry out and are worked earlier.

The surface soil is brownish-gray silt loam that has a soft fine-crumb structure and is 7 inches deep. The upper subsoil layer is dark-brown friable silt loam with a soft fine platy structure. Between depths of 12 and 18 inches the reddish-gray silt loam subsoil is firm in place and sticky and has a fine lumpy structure. This layer is faintly mottled in the upper part and becomes more strongly mottled gray, yellow, and dark brown with depth. Beneath this layer and reaching to a depth of 25 inches the subsoil is very compact reddish-gray silt loam strongly mottled yellow, gray, and dark brown and having a small irregular fragmental structure. The deep subsoil layer is dusky-red very compact loam or light silt loam having an irregular fragmental structure. It is strongly mottled in the upper part and becomes less mottled with depth. The mottling is most pronounced on the outer surfaces of the fragments.

Many angular and rounded fragments of dusky-red sandstone and shale and some gray sandstone flagstones are present in all layers. The reaction ranges from slightly to medium acid throughout. Roots penetrate the upper 18 inches of the soil most intensively, and between depths of 18 and 25 inches they do so with difficulty, as may be seen from the number of dead roots in this compact layer. Few roots reach to the deep subsoil layer.

This soil occurs mainly in the central and west-central parts of the county, in the area of intensive agriculture. Here many areas are as large as 1 square mile or more. Smaller areas are scattered throughout the other parts of the county that are underlain by red shale. The total area of Wellsboro silt loam is 94.2 square miles. This is the most extensive arable soil.

Areas of this soil are smoothly sloping, and in most places the gradient ranges from 5 to 10 percent. A few areas have a slope as

steep as 25 percent. Such steep areas generally occur at the base of long slopes. Likewise, some areas have a slope more gentle than 5 percent. Nevertheless, surface drainage is everywhere good. Internal drainage is impeded by the impervious hardpan layer.

The soils are used for nearly all of the crops grown on the better drained red soils. They are not well adapted to all crops, however, and yields are only moderate. Wellsboro silt loam is not well suited to alfalfa, although alfalfa is often used in combination seedings on this type. Ladino clover is a better long-lived legume. Corn, oats, timothy, clover, pasture grasses, and buckwheat are the common crops. Probably 10 percent of the land is idle or forested or has been reforested, 30 percent is pastured, 15 percent is in corn, 10 percent in small grains, and 35 percent is in hay. Corn yields 35 to 45 bushels of grain and 8 to 11 tons of silage an acre, and oats 30 to 35 bushels. Hay crops return a varying yield—timothy and red clover 1¼ to 1½ tons; timothy, red clover, and alsike clover 1½ to 1¾ tons; and timothy alone 1½ tons. Although alfalfa is often included in timothy and red clover mixtures, alfalfa does not do well on this soil and very little remains in second-year meadows. Alsike clover and timothy seem to make the best mixture on this soil. Potatoes are sometimes grown, but the yield is low, about 75 to 100 bushels. Buckwheat, planted as a catch crop, yields 20 to 25 bushels.

A 5- or 6-year rotation is generally practiced: Hay for 3 or 4 years, followed by corn for 1 year and oats for 1 year. In the more intensely farmed areas a 5-year rotation is followed. Some farmers extend the rotation by manuring the meadows after 2 or 3 seasons of mowing and then pasturing the meadows for 2 or even 3 years. In the common 5- or 6-year rotation 10 or 12 tons of manure and 300 to 500 pounds of superphosphate an acre are applied to the land prepared for corn. Lime is applied at the rate of 1 to 1½ tons for oats. If sufficient manure is available, light top dressings of manure are made on meadows in order to insure a better hay crop for the third year.

Pastures on Wellsboro silt loam vary considerably from poor so-called permanent pastures to excellent seeded pastures. Nearly all of the pastures contain Rhode Island bent, redtop, timothy, Kentucky bluegrass, and a trace of wild white clover. In the poorer pastures are many noxious weeds and poverty grass. The commonest weeds are devils-paintbrush, buttercup, yarrow, ferns, sheep sorrel, and hardhack. In the better pastures are few weeds and higher percentages of the more desirable pasture grasses, especially Kentucky bluegrass and wild white clover. A higher percentage of the pastures are poor, however, and large acreages are used as pasture for a few cows. In many instances if a few acres, an acre, or an acre and a half per cow were improved and properly treated, a great deal more of the land now used as pasture could be used as rotated cropland. About 10 percent of the pasture land on the Wellsboro silt loam occurs on slopes that are too steep or too irregular for cultivation. This land, however, will support good pasture with proper management, and erosion can be as well controlled as it would be if the land were in forest. There is evidence of moderate sheet erosion in the poorer pastures, especially where the stock gather at drinking areas and gates.

On the better pastures that have been seeded, applications of 1½ tons of ground limestone and from 300 to 500 pounds of superphosphate have been made when the land was prepared for seeding. Recommended pasture seedings that include Kentucky bluegrass, wild white clover, Rhode Island bent, timothy, and perennial ryegrass are usually used. Top dressings of lime and phosphates are added after a period of years as needed. Few farmers mow or rotate pastures or scatter manure on them, although these are desirable pasture practices.

The woods on this type include elm, beech, yellow birch, red maple, sugar maple, black cherry, and hemlock. All the stands are second growth. Red spruce, white pine, red pine, fir, and larch have been used for plantations.

Erosion is not a serious problem on this soil except on cornland and poorly managed pastures. By plowing and planting on the contour, erosion can be easily controlled. The characteristic long gentle slopes on which these soils occur are well suited to strip cropping. Rearrangement of the farm lay-out would be necessary on many farms, however, before this means of erosion control could be applied. As so much of this land is in grasses, the use of strip cropping is seldom necessary on this type.

Wellsboro stony silt loam.—Where it occurs in large units, Wellsboro stony silt loam is generally associated with other nonarable stony soils or rough stony land. Smaller areas are scattered throughout the intensively farmed area of the county and generally on land that is too irregular for cultivation. This soil is closely associated with the Lackawanna, Walton, and Norwich soils. Most of the area is forested or pastured.

The 6-inch surface soil beneath the forest litter is reddish-gray to dusky reddish-brown and has a mellow small granular structure. Below this the material is dusky reddish-brown mellow friable gritty silt loam. Between depths of 11 and 15 inches is a layer of reddish-gray friable gritty silt loam, which rests on a dusky-red silt loam that becomes increasingly mottled with gray, yellow, and rust brown and firm to a depth of 20 inches. It has a small irregular fragmental structure. Below this and extending to a depth of 27 inches the subsoil is dusky-red silt loam strongly mottled yellow, gray, and rust brown, is compact and gritty, and breaks into small irregular fragments. The deep subsoil layer is dusky-red very compact heavy loam strongly mottled in the upper part. With depth the subsoil becomes less mottled and breaks into large irregular medium hard fragments. Within the soil and on the surface there are many flaggy pieces of sandstone, large stones, and huge angular rocks; in fact, stones are so abundant on the surface that cultivation of this soil is impossible. The reaction is medium acid.

Areas of this soil are gently sloping to irregularly undulating or strongly sloping. A few areas have a decidedly steep slope, which is not characteristic of the series. Such areas have not been separated in mapping, as they are readily distinguished on the soil map by the closeness of contour lines. They are forested and not arable. Surface drainage is fair to rapid, but internal drainage is imperfect and slow.

The larger areas of Wellsboro stony silt loam occur in the rougher areas of the county outside of the more intensively farmed area. Smaller areas occur in the farmed area and are generally used for farm wood lots or pasture. In all, about 37.1 square miles is mapped.

About 30 percent of the land is pastured; the rest remains in second-growth forest. The principal trees are sugar maple, beech, black birch, and hemlock. Associated species are white ash, white pine, yellow birch, and elm. At the higher elevations in the northern part of the county, spruce and balsam fir also occur on this soil. Grazing is allowed on many of the farm wood lots on this and other soils; so young undergrowth is very scarce and very little grazing is afforded.

Pastures on this soil are generally poor, although most pastures contain some Rhode Island bent, redtop, and timothy and a trace of Kentucky bluegrass and wild white clover; but poverty oatgrass, many weeds, and hawthorn are generally more abundant than the desirable pasture grasses. In the better pastures, which are few, the more desirable pasture grasses predominate. Here, most of the smaller flagstones and rocks have been picked off, brush is kept down, and a top dressing of lime and phosphate is applied. On the poorest pastures hardhack and mountain-laurel are abundant, and cattle graze along the paths and in small open areas between the brush.

Culvers silt loam.—Although this soil is developed predominantly from gray sandstone materials, it also contains a small proportion of red shale and sandstone materials. This soil is closely associated with the red soils, as well as with Culvers stony silt loam. Although moderately productive, it is slightly less so than the Wellsboro soils.

The surface soil of Culvers silt loam to a depth of 8 inches is pale-brown mellow structureless light silt loam containing some gravel. The upper subsoil layer is yellowish-brown friable light silt loam without well-defined structure. Between depths of 15 and 21 inches the subsoil is medium-gray gritty loam strongly mottled with yellow and dark brown. This material is slightly compact, has a slightly red cast in places, and breaks into fine irregular fragments. Between depths of 21 and 28 inches is a layer of reddish-gray highly mottled very compact gritty silt loam, locally called hardpan. The deep subsoil layer, which reaches to bedrock, is very compact dark reddish-gray light silt loam having a medium-sized irregular fragmental structure. Partly decomposed fragments of gray and dusky-red sandstones are present in the soil. The reaction ranges from medium to strongly acid. The depth to bedrock varies, but generally it is 4 to 4½ feet. Few plant roots penetrate the deep subsoil layer, and most of them occur above the strongly mottled layer.

Most of the areas of this type are in the northern towns, although a few are scattered over the eastern part of the county. The total area is 17.7 square miles. The soil generally occurs on long gentle slopes, and the relief is gently undulating. Surface drainage is good, but internal drainage is retarded by the impervious so-called hardpan layer. The depth of mottling varies considerably, and in a few spots it occurs almost at plow depth.

About 10 percent of the land is idle, 5 percent reforested, 25 percent pastured, 15 percent in corn, 10 percent in small grain, and 35 percent in hay. The principal hay crops are timothy, alsike clover, and red

clover, generally seeded together in mixture, although the red clover does not hold so well as alsike on this soil. Generally alsike and timothy seedings result in the best yields, but Ladino clover is much to be preferred in seedings that are to stay down for several years. This is usually a late soil, and sometimes it cannot be plowed in spring in time to plant oats. Buckwheat is often planted as a catch crop. The soil is only moderately productive and slightly less so than the Wellsboro soils. Corn yields from 8 to 10 tons of silage an acre; oats 30 to 35 bushels; buckwheat 20 to 25 bushels; timothy, red clover, and alsike clover 1½ tons; timothy and alsike clover 1½ to 1¾ tons; and timothy alone 1½ tons.

A 5- or 6-year rotation of hay 3 or 4 years, corn 1 year, and oats 1 year is followed. From 10 to 12 tons of manure and 300 to 500 pounds of superphosphate are applied on the cornland, and 1 to 1½ tons of lime is applied on the land prepared for grain and seeding. This soil is not so intensively cultivated as the better drained soils of the county or as the Wellsboro soils, and the land may be left in hay for longer periods.

As with most of the imperfectly drained soils, pastures on this soil vary considerably. Few pastures are established by seeding. Generally after meadows have been mowed for 3 or 4 years cattle are turned in and the fields are then pastured for a number of years. The better farmers apply a light top dressing of manure and superphosphate on the meadows the season before they are used for pasture or in the fall after the meadows are first grazed. Most pastures on this soil, however, do not receive treatments, and the swards are thin. Fair percentages of redtop and Rhode Island bent are present in most pastures. Kentucky bluegrass, though generally present, occurs in rather low percentages, as do the pasture legumes wild white clover and red clover, especially where the pastures have received no treatment. Poverty oatgrass occurs in nearly every pasture. Varying percentages of weeds, such as daisies, devils-paintbrush, buttercup, yarrow, and sheep sorrel, are also present.

The reforested areas are mostly in the Catskill Forest Preserve and on private summer estates in the northern part of the county. Plantations include red spruce, balsam, and larch. Some white, red, and Scotch pine are also planted. In many of the abandoned fields paper birch, aspen, and elm are encroaching.

Culvers stony silt loam.—This soil differs from Culvers silt loam, with which it is closely associated, chiefly in the large quantity of stone and large rocks present on the surface and embedded in the soil mass. This stoniness, together with a thin soil mantle in many places, makes much of the land unsuitable for cultivation. Although a small area is cleared of forest and pastured, a far greater area is forested.

Beneath the litter in many forested areas there is a thin gray layer overlying a 6-inch surface layer of dark-brown or coffee-brown mellow friable and structureless silt loam. This layer is underlain by light yellowish-brown silt loam. Between depths of 10 and 18 inches the subsoil is light yellowish-brown structureless silt loam. This layer is slightly stained or mottled in the lower 2 or 3 inches. Below this the subsoil becomes strongly mottled and somewhat compact, consisting of medium-gray gritty silt loam that is strongly mottled with yellow and dark brown and has an irregular fragmental structure.

Between depths of 24 and 30 inches the subsoil is very compact and strongly mottled and the gray light silt loam has a noticeable red cast. The compact deep substratum is mixed red and gray compact till. In most places the proportion of red and gray sandstone materials is about equal and the texture is gritty silt loam. The upper few inches of the deep substratum are mottled, but mottling decreases rapidly with depth. In most areas the depth of soil is from 3½ to 4 feet, but in some bedrock lies near the surface or outcrops. Large angular rocks and boulders occur within the soil mass and on the surface. The reaction ranges from medium to strongly acid.

Culvers stony silt loam is most extensive in the northern towns of the county, but a few small areas occur in the eastern and southeastern parts. The total area is 38.3 square miles. Although this soil generally occupies long gentle slopes, the relief of some areas is rather irregular. In some places where the soil is shallow and somewhat seepy the slope is rather steep.

Probably 70 percent of the land is forested, and 30 percent of the total area and 10 percent of the woods are pastured. The forests include beech, yellow birch, black birch, sugar maple, red maple, red spruce, black cherry, balsam fir, hemlock, and mountain ash.

Pastures on this stony type for the most part are poor. Although redtop and Rhode Island bent are present in nearly all of the pastures, the proportion of poverty oatgrass, weeds, hardhack, and mountain-laurel is generally greater. Little care is usually given these pastures, and 20 or 30 acres may supply barely enough pasturage for 8 or 9 cows. Hardhack and mountain-laurel grow so abundantly that 20 to 40 percent of the area of many pastures is covered by these shrubs. On some farms this is the only land available for pastures. Improvement of selected areas in these pastures, however, would permit retiring to forest the more undesirable areas.

Culvers loam.—This is not so extensive an agricultural soil as the other imperfectly drained upland soils of the plateau region. It is more typically developed from gray sandstone materials than the Culvers silt loam and occurs in close association with the better drained Catskill and Liberty soils. The soil is only moderately productive, but many farms are situated on it.

In its cultivated condition the surface soil consists of dark yellowish-brown gritty loam. The upper subsoil layer between depths of 8 and 18 inches is yellowish-brown heavy loam that is firm in place and structureless. The lower 2 or 3 inches of this layer is stained pale yellow, gray, and dark brown. Below this the heavy loam subsoil, to a depth of 26 inches, is brownish-gray strongly mottled with pale yellow and dark brown and compact. It breaks into medium-hard irregular fragments. The compact substratum is mottled yellow and dark brown in the upper 2 or 3 inches of the layer. It is gray gritty heavy loam composed mostly of gray sandstone materials, although some red shale is present throughout the layer. Small sandstone fragments occur on the surface. The soils are acid throughout the profile. Roots penetrate the upper 26 inches of the soil but are most abundant above the mottled layer. Few roots penetrate the impervious hardpan subsoil.

Culvers loam occurs mainly in the eastern and southern parts of the county in rather small areas closely associated with areas of the

better drained gray sandstone soils. Even the largest bodies, such as those in the northeastern part of the county south of Grahamsville and in Lumberland near Glen Spey, do not exceed 450 acres. Included with this type are small areas of lighter textured sandy loam soils. These soils occur in the vicinity of Aden in the northeastern part of the county. The aggregate area of this type is 8.3 square miles.

The soil occupies long gentle slopes having a smooth to gently undulating surface. The general slope ranges from 3 to 8 percent. The relief is such that surface drainage is good, but internal drainage is imperfect, owing to the compact impervious subsoil.

Dairying is the principal type of farming followed on this soil, and corn, oats, hay, and pasture grasses are the principal crops. Much the same system of management is followed on Culvers loam as on Culvers silt loam, but on the average the productivity is probably slightly lower. Corn yields from 8 to 10 tons an acre, oats 30 bushels, buckwheat 20 to 25 bushels, timothy, red clover, and alsike clover 1¼ to 1½ tons, timothy and alsike clover 1½ to 1¾ tons, and timothy alone 1¼ to 1½ tons. About 5 percent of the land is idle, 25 percent is pastured, 20 percent is in corn, 15 percent is in small grain, and 35 percent is in hay.

Pasture conditions are about the same as on Culvers silt loam. The most outstanding difference is the complete lack in some pastures and the very low percentage in others of legumes, especially wild white clover.

On this soil and on the silt loam, erosion is not generally a serious problem with good soil management. Where slopes are plowed up and down, however, rather than across, gullies form in places in the dead furrows. The same thing happens when row crops are run with the slopes. Although these imperfectly drained soils tend to be erodible, plowing and planting on the contour should give adequate control in most places. Where the slopes are long and adapted to the practice, strip cropping may be advisable.

Culvers stony loam.—This is primarily a forest soil. It occurs in large areas in Lumberland, Forestburg, and Neversink, closely associated with Catskill stony loam. It differs from the Culvers loam in having an abundance of large stones and huge boulders on the surface and within the soil mass.

In forested areas there is a 2- or 3-inch litter over a layer of ash-gray gritty loam 1 or 1½ inches thick. Beneath this layer the soil is dark brown to a depth of 9 inches. The layers below this depth resemble the lower layers of Culvers loam. The characteristic hardpan layer impedes drainage and prohibits the penetration of the roots of most trees, as is indicated by the number of dead roots in this layer. Bedrock generally lies 48 inches or more below the surface, although some areas of a shallower soil are included. As in most of the types of the Culvers series, the depth of the mottled layer varies, and on the more nearly flat areas mottling may occur at a depth of 8 or 10 inches.

An area three-fourths of a mile north of Beaverdam Pond included in mapping differs from the normal soil in containing stratified sands and gravel in the surface layers. Also in the vicinity of Aden, which is northwest of the community of Neversink, the soils of this type as shown on the map are lighter in texture than normal—approximately

sandy loam—but because of small extent and only minor differences in agricultural value these areas are included with Culvers stony loam.

The slopes of this soil range from nearly flat to gently sloping, but surface drainage is everywhere good. Internal drainage is imperfect, however, owing to the characteristic impervious hardpan layer.

At least 70 percent of this land is forested. In the southern part of the county the forested areas include beech, yellow birch, black birch, sugar maple, red maple, and hemlock. Forests in the northeastern and eastern area of the county include not only the above-mentioned trees but also red spruce and balsam fir, especially at the higher elevations. About 10 percent of the forested area is pastured.

Nearly 30 percent of the land has been cleared of forest and is pastured. Pastures receive very little if any care and are generally poor. Redtop and Rhode Island bent are the best grasses found in the pastures. Poverty oatgrass is present in greater abundance and, together with noxious weeds, mountain-laurel, and hardhack, has almost crowded out the better grasses. In some pastures laurel or hardhack makes up 50 to 75 percent of the cover. Where this is the best land available for pasture, the carrying capacity in most places could be greatly increased by clearing the brush, removing smaller stones, and treating the pasture with lime and fertilizer.

Pittstown silt loam.—This imperfectly drained soil occurs in the southeastern corner of the county in the vicinity of Winterton. It occupies the lower slopes and smoother areas associated with the Dutchess soils. The soil is not very extensive, but it is all used for either pasture, hay, or cultivated crops.

The surface soil in cultivated areas is weak-brown silt loam, about 8 inches deep. It is structureless and contains some gravel and shale fragments. The upper subsoil layer, structureless and friable, is light yellowish-brown gravelly silt loam. Between depths of 18 and 30 inches the subsoil is brownish-gray gravelly loam strongly mottled with pale yellow, dark brown, and gray. It is compact and breaks into small irregular fragments. The deep subsoil layer below is medium olive-gray compact light gravelly loam. Fragments of shale and sandstone and boulders of quartz conglomerate are numerous throughout. Roots thickly permeate the upper layers, but few roots penetrate the mottled layer.

The soil occupies the lower slopes of the mountains in a valley-fill position. The relief is smoothly undulating to gently sloping. Surface drainage is good, but internal drainage is slow or imperfect. Only 320 acres of this soil is mapped.

Corn, oats, and hay are the principal crops. The soil is moderately productive, and under present management corn produces from 8 to 12 tons of silage and 35 to 45 bushels of grain to the acre; oats 30 to 35 bushels, or, when cut green, about 1½ to 2 tons of forage; timothy, alsike clover, and red clover mixed, 1½ to 1¾ tons of hay; and timothy and red clover 1¼ to 1¾ tons. Hay yields of old meadows would be greatly increased if Ladino clover were used as the legume.

A 5- or 6-year rotation is followed on this soil as on the Dutchess soil: Corn 1 year, grain 1 year, and hay 3 or 4 years. From 10 to 12 tons of manure and 300 to 500 pounds of superphosphate are applied to the land prepared for corn, and 1 to 1½ tons of lime is applied on the oatland. Sometimes after meadows run out they are top-dressed

with manure and phosphate and then pastured. About 40 percent of the land is pastured, 15 percent is in corn, 10 percent is in oats, and 35 percent is in hay. Erosion is not a serious problem, and, where cultivation and plowing is done across the slope, little erosion results. Pastures are generally fair to good. Most of them contain Rhode Island bent, redtop, timothy, wild white clover, and Kentucky bluegrass. In nearly all of the pastures some poverty oatgrass and some undesirable weeds are present.

Pittstown stony silt loam.—This soil is closely associated with the Pittstown silt loam in one body, totaling 256 acres, near Winterton. This body occupies the lower slope of the mountains and is rather steep. It is used principally for pasture, and part of it is idle. This soil differs from Pittstown silt loam not only in the steeper slope but also in the abundance of loose boulders scattered about the surface.

The soil profile is similar to that of the Pittstown silt loam, but boulders and rock masses of sandstone, shale, and quartz conglomerate are so abundant that the land is unsuitable for cultivation. All the land has been cleared of trees, however, and at one time it was pastured. At present about 35 percent of the land is idle; the rest supports only fair pasturage. Although the pastures contain Rhode Island bent, redtop, timothy, and some Kentucky bluegrass and wild white clover, the percentage of poverty oatgrass and noxious weeds equals or exceeds that of the better grasses. Brush and young trees are invading the pastures and idle land.

Wurtsboro sandy loam.—This soil occurs only on the Shawangunk Mountains in the southeastern corner of the county. The soil has a moderate to low agricultural value and is used principally for pasture.

In pastured areas the surface soil is light brownish-gray or pale-brown heavy sandy loam or light gritty loam. The soil material is friable and structureless. Below plow depth, or a depth of 7 inches, the first 5 inches of the upper subsoil layer is yellowish-brown structureless friable gravelly loam. Between depths of 12 and 18 inches the subsoil becomes firm or slightly compact, consisting of yellowish-brown gritty silt loam that is marbled with gray and rusty brown and breaks into small irregular fragments. Below this the subsoil becomes compact and strongly mottled, and to a depth of 35 inches it is weak-brown silt loam mottled with yellow, dark brown, and gray. It breaks into platy or irregular fragments. A deep substratum of very compact unweathered gravelly silt loam reaches to a depth of 12 feet or more. It has an irregular fragmental structure, and the fragments are hard. Many large stones and small boulders are present throughout. The parent materials are mostly quartz conglomerate and about 20 percent shale and sandstone rocks. The reaction is moderately to strongly acid throughout.

About 2.1 square miles of this soil is mapped. The relief ranges from gently to strongly rolling. Surface drainage is good to excessive, but internal drainage is slow or imperfect, owing to the impervious compact hardpan subsoil.

About 3 percent of this land is in residential areas, 5 percent is idle, 10 percent is in corn, 7 percent is in small grains, and 25 percent is in hay; the rest is pastured. Crops are raised in support of dairying, but yields are moderate to low. The soils are not intensively cultivated, and no definite rotation seems to be followed on them.

Usually 1 year of corn is followed by 1 year of small grain seeded to timothy, clover, and alfalfa. Ladino clover tolerates imperfect drainage much better than alfalfa and is longer lived than red clover. The hay land is usually maintained until the crop is poor and weedy. The land may then be pastured for a time or plowed and planted to corn again. Corn yields 7 to 10 tons of forage and 30 to 35 bushels of grain to the acre, oats 30 to 35 bushels or 1¼ to 1½ tons of forage cut green, and timothy and clover 1¼ to 1½ tons.

From 8 to 10 tons of manure and about 300 pounds of superphosphate are applied to the land for corn, and 1 to 1½ tons of lime for oats. Light top dressings of manure are applied on the hay land by the better farmers. The soil is moderately eroded, and sheet erosion is evident in most pastures and in fields planted to row crops. In the poorer pastures small gullies are not uncommon. Erosion of cornland and plowed land can be prevented by planting and cultivating on the contour. Improvement of pastures by the addition of lime and phosphate and in some instances by reseeding will help to control erosion.

Pastures are generally poor on this soil, and the percentage of poverty oatgrass and weeds is very high. Redtop and Rhode Island bent are the best pasture grasses present, although the better pastures contain some Kentucky bluegrass and wild white clover. Brush, hawthorn, and scrub apple from abandoned orchards occur in many pastures. In general the herbage is poor and the carrying capacity is low under present management.

Wurtsboro stony sandy loam.—This is primarily a forested soil, and at least 90 percent of the area supports a fair second growth of hardwoods. The remaining area is pastured.

In forested areas beneath the forest litter and a thin layer of nearly black fine-crumb mull, the soil is light-gray leached gravelly sandy loam. This sandy material is single grained, very porous, and structureless. Between depths of 4 and 11 inches the upper subsoil layer is dusky-yellow heavy gravelly loam that is mealy and structureless. Below this layer the subsoil becomes slightly compact and slightly stained, consisting of yellowish-brown gritty silt loam having a fine lumpy structure. Between depths of 18 and 23 inches the soil is pale-brown compact silt loam strongly mottled with yellow, gray, and rust brown. It has a platy fragmental structure. The deepest subsoil layer is very compact hard weak-brown gritty silt loam, reaching to a depth of 34 inches. The soils have a lumpy structure, and along the breakage planes the fragments have a light-gray coating stained with yellow and dark brown. The substratum is very deep and extends to a depth of 12 feet or more. It consists of a weak-brown unweathered gravelly silt loam that has a small clod structure. Throughout the profile and scattered over the surface there are many boulders and huge conglomerate rocks. About 85 percent of the soil material is quartz conglomerate, and the rest is shale and sandstone. The reaction ranges from very strongly to medium acid.

Fairly large bodies, totaling 6.6 square miles, occur on the slopes of the Shawangunk Mountains. The relief ranges from gently sloping to steep. Surface drainage is good, but internal drainage is imperfect, owing to the impervious hardpan layer. Roots freely

penetrate the upper layer, but very few roots occur in the strongly mottled layers. Many of the roots in the mottled layers are dead.

The forest cover is composed of chestnut oak (rock oak), sassafras, red maple, white ash, red oak, white oak, and tuliptree. The undergrowth includes mountain-laurel, huckleberry, striped or goosefoot maple (*Acer pennsylvanicum* L.), ferns, and wintergreen. That chestnut grew abundantly on these soils is evidenced by the large number of dead trees and still living sprouts. Although blight is evident on most of the sprouts, some of them are producing burs.

Pastures on this soil are very poor. About 80 percent of the cover is composed of poverty oatgrass, yarrow, goldenrod, sheep sorrel, devils-paintbrush, hawthorn, and scrub apple. Rhode Island bent and redtop are the best pasture grasses present. The pastures receive little if any care, and their carrying capacity is very low.

POORLY DRAINED SOILS OF THE UPLANDS

The poorly drained soils of the uplands occupy only about 7 percent of the total area of the county. They are widely distributed, generally in small areas, most of which are used for pasture or forest. The series included in this group are Norwich and Mansfield. The soils of the Norwich series are the most extensive.

The Norwich series includes poorly drained acid soils associated with the other soils of the uplands in the plateau region of the county. They have developed from unassorted glacial debris composed of red sandstone and shale, containing a varying admixture of gray sandstone and shale. These soils occur in depressed or low areas between areas of better drained soils, at the heads of streams, and along the edges of lakes. The Norwich soils are characterized by a brownish-black surface soil, a medium-gray mottled upper subsoil layer, and a compact dark reddish-gray or dusky-red strongly mottled deep subsoil layer. The land is generally level to gently sloping, but some seepy slopes are rather steep. Variations within the profile are chiefly in depth of the soil mantle and in the color of the subsoil. Norwich silt loam and Norwich stony silt loam are mapped in this series in Sullivan County.

The Mansfield series includes a poorly drained acid soil. It has developed from moderately deep deposits of compact glacial till composed mostly of acid slates and shales with an admixture of some of the local quartz conglomerate. The land is flat to gently sloping. This soil occurs in flat or depressed areas in association with areas of the better drained soils of the Dutchess, Nassau, and Wurtsboro series. It has a dark-gray to olive-black surface soil, a mottled yellowish-brown upper subsoil layer, and a compact mottled brownish-gray deep subsoil layer. Mansfield stony silt loam, the only member of the series mapped in Sullivan County, occupies a very small total area in the southeastern part of the county. Nearly all of the land is cleared and used for pasture.

Norwich silt loam.—This is the less extensive of the two Norwich soils, but it is the more widely used not only for pasture but also as hay land. Some narrow strips along areas of the better drained soils are planted and cultivated.

The 9-inch surface soil is brownish-black to dusky-brown silt loam streaked with dark brown. The lower few inches of this layer are generally slightly mottled. The upper subsoil layer is dark reddish-gray plastic heavy silt loam, contains some gravel and sandstone fragments, and is highly mottled with yellow and dark brown. Between depths of 16 and 32 inches the subsoil is brownish-gray gritty silt loam strongly mottled with yellow and rust brown. It is compact and has an irregular fragmental structure. Below this the deep subsoil layer is reddish-gray or dusky-red compact but friable silt loam. It contains considerable gritty material and undecomposed red and gray sandstone and shale. The soil ranges from very strongly acid in the surface soil to strongly acid in the deep subsoil.

The soil is widely distributed in small areas, totaling about 16.2 square miles, throughout the county. The largest ones cover only about 150 acres. Most of them are flat or only gently sloping, and few have a slope exceeding 3 percent. Both surface and internal drainage are poor.

The principal use of Norwich silt loam is for pasture. A few areas are plowed and used for hay. The pastures vary considerably on this type but in general are fair. The cover includes wild white clover, Kentucky bluegrass, and bentgrasses, with varying percentages of coarse reedy grasses, sedges, and weeds. Although most of the pastures on this soil are fairly well grazed and brush is kept down, the poorer pastures contain hardtack, rose briers, mountain-laurel, and trees. Approximately 85 percent of the land is pastured.

About 5 percent of the soil is in meadow. Timothy, redtop, and alsike clover are the principal plants in the seeding mixtures. Yields range from 1 to 1½ tons an acre. The remaining 10 percent of the land is idle and is being invaded by hemlock, pin cherry, birch, elm, red maple, and black ash.

Norwich stony silt loam.—This is the most extensive of the poorly drained soils. Most of the areas occur as narrow strips or depressions among the areas of better drained soils, generally at the heads of streams, around lakes, or on wet seepage slopes.

The profile of Norwich stony silt loam closely resembles that of the nonstony Norwich soil, differing mainly in the abundance of large stones, boulders, and flagstones on the surface and within the soil mass. In some areas, especially in wooded and depressed areas, the surface soil has a mucky or organic layer and is nearly black. On pastured areas the surface soil is dusky brown. The reaction is very strongly acid throughout. In the southern, eastern, and northeastern parts of the county, where this soil is developed almost entirely from gray sandstone materials, the deep subsoil does not have the reddish cast characteristic of these soils in the areas underlain by red shale and sandstone.

The soil is well distributed throughout the county. Although most of the areas are small, a few include 500 acres or more. In all, they cover 51.6 square miles.

Because of its close association with better drained land that is pastured, about 40 percent of this land is in pasture. In general, however, pastures are poor, since various coarse reedy grasses, sedges, weeds, shrubs, and trees occupy some of the land and lessen its value.

In places, mountain-laurel and hardhack, the most abundant shrubs in pastures, make up from 50 to 80 percent of the cover. Bluegrasses, timothy, and wild white clover occur in the better pastures. Many of the wooded areas are pastured, but they do not afford much herbage.

The forest growth on this soil varies, but it includes mostly moisture-loving trees and an undergrowth of rhododendron, mountain-laurel, and ferns. The principal trees are hemlock, red maple, black ash, white ash, elm, silver maple, and yellow birch. In the northern part of the county balsam fir, paper birch, and some red spruce grow at the higher elevations.

Mansfield stony silt loam.—This is the poorly drained associate of the upland soils on the southeastern slopes of the Shawangunk Mountains. It occurs in small units, generally at the heads of streams or in depressions within areas of better drained soils. Most of the land has been cleared of forest and is pastured, and a few small areas have been cleared of stones.

In pastured areas the surface soil to an average depth of 7 inches is dark gray to olive black and streaked with dark brown. The upper subsoil layer is yellowish-brown heavy silt loam strongly mottled with gray, yellow, and dark brown. The soil is slightly compact but friable to a depth of 15 inches. Between depths of 15 and 28 inches the lower subsoil layer is compact heavy silty clay loam and is highly mottled yellow, dark brown, and gray. The deep substratum is brownish-gray or olive-gray heavy silt to silty clay loam. The unweathered till material contains a large proportion of shale and a small proportion of quartz conglomerate. There are many conglomerate and sandstone boulders throughout the soil mass and on the surface. The reaction is medium acid throughout.

Few areas of this soil exceed 25 or 30 acres, and the total area is only 768 acres. The land is practically flat, having in few places a slope greater than 2 or 3 percent. Surface drainage and internal drainage are slow and poor.

With the exception of a few small narrow strips that have been cleared of stones and are intermingled with intensively cultivated soils, practically none of this soil is cultivated. Most of it is used for pasture. It supports fair to good pasture plants, including bluegrasses, bentgrasses, and a fair percentage of wild white clover. Coarse reedy grasses and flags grow in the wettest areas, however, and ferns, daisies, buttercup, mullein, sorrel, and other weeds grow.

The few areas that are wooded include hemlock, red and silver maple, elm, and black ash in the forest stand.

SOILS OF THE TERRACES AND KAMES

The soils of the terraces and kames occur in small areas along the major streams of the county and as cone deltas or alluvial-fan phases at the mouths of the tributaries to the major streams. These terraces occupy only about 4 percent of the county. The largest areas occur in the valley of Basher Kill northeast and southwest of Wurtsboro. The relief ranges from almost level terraces to the steep faces of the terraces and the hummocky relief of the kames. With one exception all these soils are well drained, a condition reflected in the uniform gradation of color throughout and in the vegetation. The Braceville

soil is imperfectly drained and has a distinctly mottled subsoil. The well-drained soils of the terraces include those of the Tunkhannock and Chenango series, and the soils of the hummocky kames include those of the Colchester and Otisville series.

The soils of the Tunkhannock and Chenango series are the most important of this group. As a rule, they have loamy sand to loam surface soils and loose gravelly subsoils. They are used for the production of practically all of the crops grown in the county. These soils are not naturally fertile, especially the loamy sand members, but they respond well to good management and all are moderately to highly productive when plant nutrients are supplied. They are free of stones and easily cultivated with modern machinery.

The soils having a hummocky surface—the Colchester and Otisville soils—are less valuable for crops than those having a smoother surface. They are more droughty because of excessive drainage.

The Tunkhannock series includes dark reddish-gray to reddish-gray soils developed from acid water-assorted gravel and sand. These parent materials are derived from deposits of glacial streams—water-assorted material composed mostly of red and reddish-gray sandstone and shale mixed with gray shale and sandstone. The red shale and sandstone predominate sufficiently to give the soil a pinkish-red to grayish-red color throughout the profile. These soils occur on the higher terraces of the valleys at elevations of 20 feet or more above the present level of streams and are associated with the Walton and Lackawanna soils. With the exception of the soils of the cone deltas on the alluvial fans which in severe freshets may be flooded, these soils are not subject to flooding by the present streams. The Tunkhannock soils are characterized by a uniform gradation of color from a light reddish gray in the surface soil to an Indian red or dusky red in the deep subsoil. Variations in the quantities of gray and olive-drab shale and sandstone mixed with the red shale and sandstone cause considerable variation in the intensity of the color. Variations in color and texture are the chief differences in this series. The land is flat to gently undulating. Drainage is good and mostly internal.

Tunkhannock gravelly loam; Tunkhannock gravelly loam, alluvial-fan phase; and Tunkhannock loamy sand are recognized in this series.

The Colchester series includes soils similar to those of the Tunkhannock series but having a hummocky relief. They are developed from similar parent materials, which are water-assorted and composed mostly of red shale and sandstone mixed with light olive-gray and gray sandstone. The soils have a uniform gradation of color throughout the profile and a loose open character of the various layers. The intensity of color, from a pinkish brown to a red, depends on how much gray sandstone is present. The depth of layers and strata of coarse gravel varies considerably. The relief is irregular and hummocky. Areas of these soils occur in lateral belts along the valleys and within the bends of the valley. Other areas occur as isolated knolls or kames in the valley bottoms, as in the vicinity of Mongaup Valley. Colchester loamy sand and Colchester gravelly loam are mapped.

The Chenango series includes brownish-gray to pale-brown soils developed from parent materials derived from water-assorted gravel and sand composed of gray sandstone and shale, quartz, and other

foreign materials. Most of the terraces occupied by these soils are in the valleys of Basher Kill and Shawangunk Kill northeast and southwest of Wurtsboro and Bloomingburg, where waters from the melting glaciers flowed in great volume during the Ice Age. They are characterized by a light brownish-gray surface soil, a pale brown upper subsoil layer, and a loose yellowish-brown lower subsoil layer. Drainage is good, but it is mostly internal because of the flat to slightly undulating surface. These soils lie from 20 to 30 feet above the flood plains of the present streams and are never flooded. Variations within the series are chiefly in the texture and depth of the several layers. In general the subsoils of the sandy soils are looser and more open and porous than that of the loam. Chenango gravelly loam and Chenango gravelly sandy loam are mapped in Sullivan County.

The Otisville series includes soils similar to those of the Chenango series, but the relief is hummocky or kamelike. The soils are developed from similar parent materials, which are water-assorted gravel and sand composed of acid sandstone, shale, quartz, and other rocks. The soils have a uniform gradation in color from pale brown in the surface soil to yellowish brown in the subsoil; stratification of the subsoil; and a loose, open, and porous character in all layers. The relief is hummocky, typical of kettle-kame topography. Areas of these soils occur as laterals along the valley or as isolated knolls in the valley bottoms. Variations within the series are mostly in the texture and depth of the various layers and the open or porous character of the subsoil. Erosion of the surface soil varies considerably, but in many areas it has been severe. Drainage, both surface and internal, is good to excessive.

Two types, Otisville gravelly loam and Otisville gravelly sandy loam, are mapped. Most of these soils are idle or in pasture. They support poor pasturage in most places where no treatments of the soil have been made. Because of the unfavorable relief and the leachy nature of the soil, many areas of these soils are undesirable for cultivation.

The Braceville series includes an imperfectly drained acid soil developed from glacial-stream materials composed of acid sandstone, shale, quartz, and other gravel, like that of the Chenango soils. The surface soil and upper subsoil layers of this series, though heavier, are similar to those of the Chenango series in color. The deeper subsoil is firmer for a considerable depth, however, and is strongly mottled. Stratification of the mottled layer is not very definite, but below this layer the soil is definitely stratified and a grayish yellow brown in color. This soil occurs in flat areas, on gently sloping areas at the edges of the Chenango terraces, or where these terraces merge with the soils of the present stream flood plains. It is not flooded, however, by the present streams. Surface drainage is generally fair, but internal drainage is imperfect. Variations within the series are principally in the depth or intensity of mottling of the subsoil. Braceville silt loam is the only member of the series mapped in this county.

Tunkhannock gravelly loam.—Of the reddish-gray soils of the terraces, Tunkhannock gravelly loam is the most important agriculturally. After being limed and fertilized, this soil is well suited

to all the crops commonly grown in the region. It is well distributed throughout the major valleys of the county, although it usually occurs in small areas. The average area includes about 45 to 50 acres, and the largest is less than 300 acres. Wherever these soils are accessible they are intensively cultivated.

The surface soil, 9 or 10 inches deep, consists of mellow, structureless light to dark reddish-gray gravelly loam. The upper subsoil layer is dark yellowish-brown gravelly sandy loam having a slightly red cast. The soil is mellow, friable, and structureless. Between depths of 16 and 24 inches the subsoil is light reddish-gray to reddish-gray very firm but friable gravelly loam. Below this the subsoil is a mixture of reddish-brown loose water-worn gravel, coarse sand, and fine sand in places somewhat assorted in strata. The gravel consists mostly of red sandstone and shale with lesser amounts of gray sandstone, sandstone conglomerate, and a few other foreign gravels.

In a few areas, especially in the southern half of the county, the soils are lighter in color, the normal reddish cast being scarcely noticeable. Here the percentages of gray sandstone and of red sandstone and shale is about equal. A few areas of this soil have a well-developed light-gray surface soil and a dark-brown subsoil. The largest and most notable area occurs along Lybolt Brook southwest of Mongaup Valley. An area 3 miles southeast of Monticello and east of the New York, Ontario & Western Railway has large boulders and stones on the surface and the outward appearance of glacial till. The soil materials, however, are definitely water-deposited and are well stratified in the lower layers.

Areas of this soil are widely scattered over the county. The largest ones occur near Mongaup Valley, northeast of Willowemoc, east of Eureka, and at Debruce. In all they cover 5.5 square miles.

Normally the surface is nearly level or slightly undulating. A few areas and the narrow faces of the terraces are more uneven and rather sloping, resembling Colchester gravelly loam in relief. Drainage is mostly internal and good to excessive.

Corn, oats, timothy, red clover, alfalfa, and a few vegetables are the principal crops. The soil is intensively cultivated, and few areas are in pasture. Several small areas of this soil are either inaccessible or are isolated from other agricultural soils and are forested. A few areas in the southern part of the county now included in private hunting and summer estates or in watershed areas of the light and power company are idle or have been reforested. About 5 percent of the land is idle, 12 percent forested, 20 percent in corn, 15 percent in small grains, 3 percent in vegetables, and 40 percent in hay; the remaining 5 percent is in pasture.

A somewhat variable 5- or 6-year rotation is followed on this soil. The rotation most commonly practiced is hay 3 or 4 years, followed by corn, then oats, each 1 year. A popular rotation is hay 3 years, corn 2 years, or corn 1 year and vegetables 1 year; and this may be followed by oats 1 year. From 8 to 12 tons of manure and 300 to 400 pounds of superphosphate are applied on the cornland. Lime is applied on the land prepared for oats and seeding. On soils used for vegetables from 300 to 1,200 pounds of commercial fertilizer, 5–8–7 being the commonest used, is applied. Hay mixtures are seeded gen-

erally and include timothy, red clover, and alfalfa, or timothy and alfalfa, or timothy and red clover. Top dressings of manure are sometimes applied on hay land. Good yields of all crops are generally obtained from these soils. Corn yields from 12 to 16 tons of silage and 45 to 55 bushels of grain to the acre, oats 35 to 50 bushels, timothy and red clover 2 to 2¼ tons, timothy, red clover, and alfalfa 2¼ to 3 tons, and timothy and alfalfa 2½ to 3 tons. In dry seasons crops on this soil suffer from drought and yields are somewhat lower.

Erosion is not a problem on this soil except on the faces of the terraces, where sheet erosion is moderate. Where the row crops can be planted and cultivated on the contour, erosion can easily be controlled, even on the faces of the terraces.

Forests on this type include beech, black birch, sugar maple, black cherry, elm, white ash, and white pine. Plantations include mostly red pine, white pine, and Scotch pine. Growth is rapid on both the plantations and the old stands. Sumac and aspen come in rapidly in young plantations and idle areas.

Tunkhannock gravelly loam, alluvial-fan phase.—This soil occurs only as cone-deltas at the mouths of minor streams leading into the major valleys. Generally the fans are not more than 50 to 60 acres in size, and most of them are along the Tenmile River or its branches in the southwestern part of the county. Occasionally streams overflow after unusually heavy rains or rapid spring thaws, and the floods deposit fresh materials on the surface of these fans.

The soil profile is irregular and at the head of the deltas includes mostly coarse gravel, sand, and small rocks. At the center and outer edges of the fans the soil materials are finer textured and adapted to cultivation. The texture of the surface soil varies considerably in the same area, and at the outer edges of the fans it is apt to be silt loam. Productivity of the soils at the head of the delta is somewhat lower than that of the central part of the fans. The slope is greater than that of the normal phase, ranging from 3 to 5 percent. Drainage is good and mostly internal. The coarse materials at the mouth of the delta are usually droughty.

Tunkhannock loamy sand.—Although less extensive than Tunkhannock gravelly loam, this soil is well distributed within the county. It is closely associated with the other soils of the terrace. This type differs from most Tunkhannock soils in the upper layers, which are almost or entirely free of gravel and to a depth of 18 to 20 inches are composed of loamy coarse to fine sand. If sufficiently manured to increase the moisture-retention capacity in dry periods, this soil will produce moderate to high yields.

The 8-inch surface soil is mellow, structureless, and weak brown. The upper subsoil layer to a depth of 20 inches is pale-brown or weak reddish-brown slightly firm sandy to fine sandy loam. Below this the subsoil is a loose mixture of gravel, coarse sand, and fine sand, which is somewhat assorted or stratified. In some areas, especially in the southern part of the county, the soil lacks the characteristic red cast in the deep subsoil and throughout the profile. The subsoil is composed of red shale and sandstone in equal proportions with gray sandstone in most areas.

Tunkhannock loamy sand occurs in narrow belts adjacent to the valley walls or in broader areas at the junctions of streams. Some

of the largest areas border the Mongaup and Neversink Rivers. Few areas exceed 100 acres in size, and the average area includes from 30 to 40 acres. In all, about 2.8 square miles are mapped.

Areas of this soil range from flat to gently sloping or undulating. Drainage is mostly internal and good to excessive. Some of the faces of the terraces are steep and undergo some erosion under poor management. On the soil as a whole, erosion is not a problem.

About 20 percent of the land is forested or idle, including areas in the hunting and the light and power reserves and areas that are isolated from other agricultural soils. The principal trees are red, chestnut, white, and black oaks, pitch and white pine, and sugar maple. Red, white, and Scotch pine have been set in plantations. On the idle areas broomsedge and poverty oatgrass, devils-paintbrush, sumac, and other weeds and brush are common.

About 20 percent of the soil is in corn, 15 percent in small grains, 35 percent in hay, and 10 percent in pasture. Because of the smooth surface and the absence of stones and gravel, this soil is easily cultivated and is rather intensively used. The productivity is somewhat low, however, probably because of the porosity and droughty character of the soil. The soil is not naturally fertile and requires manure, phosphates, and lime. Under proper management moderate to fair yields are obtained. Corn for silage yields 8 to 10 tons and oats 30 to 35 bushels to the acre. Hay crops vary and are usually planted in mixture. Timothy, clover, and alfalfa yield 1½ to 2 tons and timothy and red clover 1¼ to 1¾ tons. No mammoth clover seems to be grown on this type, although it would seem better adapted to these soils than the red clover. Buckwheat, occasionally grown on this soil, yields about 20 bushels.

A 5-year rotation is generally practiced, including 3 years of hay followed by 1 year of corn and 1 year of oats. Corn is sometimes planted for 2 years in the rotation; or hay crops, if fair, may be maintained for 4 years. From 10 to 12 tons of manure and about 300 to 500 pounds of 16-percent superphosphate are applied on the land prepared for corn. About 1 ton of ground limestone—a rather small application of lime for this acid soil—is applied on the land prepared for oats and hay seeding. Top dressings of manure on the hay land are made by the better farmers in order to improve the stands and to protect the crops from drought. Where this practice is not followed the meadows are generally poor the third season.

Colchester loamy sand.—This soil is closely associated with Tunkhannock loamy sand but has an irregular or hummocky relief, which, together with the porous, leachy character of the soil, makes it generally undesirable for farming. The soil is very droughty.

The surface soil to a depth of 6 inches is weak-brown and structureless heavy loamy sand or loamy fine sand. The upper subsoil layer is pale-brown loose single-grained sandy loam containing many small pebbles of red and gray sandstone and shale. Between depths of 16 and 40 inches the lower subsoil layer is weak-red or dark reddish-gray gravelly sand that is rather firm in place but very porous. Below this the deep subsoil layer consists of very porous coarse gravel, pebbles, and sharp sand. The materials, which are somewhat assorted, are derived chiefly from red shale and sandstone, principally mixed

with some gray sandstone and quartzite material. The reaction is medium to strongly acid throughout.

In the southern and eastern parts of the county where there is a greater abundance of gray sandstone material in the soil mass, the color is much lighter than is characteristic of the normal Colchester soils. This is particularly noticeable on the kames north of Yulan, at Eldred, north of Mongaup, at Hartwood, and north of Denton Falls on the Neversink River, all of which kames border streams in the southern part of the county.

This soil is distributed throughout the county, but more areas are in the southern half. Most of the areas are small—30 or 40 acres in size—although a few include nearly 300 acres. One of the largest bodies is near Mongaup Valley; another is 2½ miles southeast of Monticello. The aggregate area is about 6.3 square miles.

About 90 percent of the land has been cleared of forest. The soil, however, is of low productivity and is not well suited to farming. About 30 percent of the land is idle, and 60 percent is pastured. Because of the droughty and leachy character of this soil, pastures on it are poor. Few of them receive any treatment, and desirable pasture grasses are scarce. The dominant grasses found in most pastures are poverty oatgrass and broomsedge. These are intermixed with an abundance of yarrow, goldenrod, wild carrot, devils-paintbrush, mullein, ragweed, aster, and other weeds. Deep-rooted birdsfoot trefoil is probably one of the best legumes for pasture improvement.

Forests on this type support fair stands of red oak, white oak, white pine, pitch pine, sugar maple, red maple, and chestnut oak. Pin cherry and birch are invading many idle areas, which also support weeds common in pastures, bromegrass, and many briers.

Although drainage is mostly internal and excessive, many of the soils in pastured areas are moderately to severely eroded. Almost all of the surface soil in some areas has been lost. There is also some wind erosion on the barren knolls.

Colchester gravelly loam.—This soil is closely associated with Tunkhannock gravelly loam and is rather widely distributed throughout the county. It occurs chiefly in the northern part of the county, and it is a slightly better soil than Colchester loamy sand. The soil has slightly more body and is not quite so porous as the loamy sand. Even though Colchester gravelly loam is somewhat dry, a small acreage of red clover, timothy, and alfalfa is grown on the smoother areas. It produces fair pasture in spring and fall, but pastures suffer during the drier summer months.

The surface soil to a depth of 8 inches is weak-brown or weak reddish-brown rather heavy loam. It is friable and structureless and contains considerable egg-sized gravel. The upper subsoil layer to a depth of 16 or 18 inches is pale-brown heavy gravelly loam or light silt loam that is friable and structureless. The lower subsoil layer, reaching to a depth of 24 inches, is dark reddish-gray gravelly coarse sand that is loose and porous. Below this the material consists of strata of loose gravel, sand, and cobblestones variously stratified and cross-bedded. The materials are mostly red shale and sandstone gravel mixed with some gray sandstone gravel. In the southern part of the county this soil contains more gray sandstone gravel and

the soils are somewhat lighter in color and texture throughout, as compared with the soil in the northern part.

The soil occupies small mounds and ridges along the sides of the valleys and a few isolated knolls on the terraces or first bottoms along the major streams. Most of the areas are small, including from 30 to 50 acres, but one large area east of Eureka includes about 100 acres. The aggregate area is about 5.4 square miles.

At least 10 percent of the land is forested, 10 percent is idle, and 15 or 20 percent is in hay crops; the rest is pastured. Hay seedings are usually made in mixture commonly of timothy, red clover, and alfalfa. Yields vary considerably from season to season but average between 1¼ to 1½ tons an acre. Only the more nearly smooth areas are in hay. Heavy applications—12 tons or more of manure and 300 to 400 pounds of superphosphate to the acre—are used when preparing the land for hay crops. Lime is applied at the rate of 1½ tons an acre at the time of seeding. When the hay crops run out, the meadows are usually pastured. No regular rotations are followed on this soil.

A few of the better pastures on these soils are top-dressed with manure, phosphate, and lime to improve and maintain better stands of desirable pasture grasses. Birdsfoot trefoil is a promising legume for these soils. These pastures contain timothy, wild white clover, red clover, Kentucky bluegrass, and some bentgrasses, together with a few undesirable grasses and weeds. Pastures range from these, the best, to ones consisting entirely of weeds and poverty oatgrass. With moderate applications of lime, manure, and phosphate, however, fair pastures can be maintained in most areas, and good grazing can be obtained in spring and fall. A few areas, however, are too steep for the use of farm machinery in spreading manure and other amendments.

Forests on this soil include sugar maple, yellow birch, red maple, beech, white pine, and black cherry. Reforested areas have been planted with white, red, and Scotch pine and apparently in one area with oak. The mortality of seedlings in some plantations has been fairly high, whereas in others it is not noticeable. On idle areas encroachments of pin cherry and aspen are common.

Chenango gravelly loam.—This is the most intensively cultivated type of the Chenango series. It is not naturally fertile, but, when sufficient manure and other plant nutrients are added, it is well suited to the production of most of the crops commonly raised in the county. Because of the favorable relief and freedom from stones it is easily cultivated and worked with labor-saving machinery. The soil occurs in much larger units than the Tunkhannock soils.

The 10-inch surface layer is brownish-gray to pale brown, mellow, and without a well-defined structure. The upper subsoil layer is pale-brown heavy gravelly sandy loam that is massive, friable, and structureless. Between depths of 20 and 60 inches the subsoil is light yellowish-brown gravelly coarse sand and coarse sandy loam. This material is loose and structureless and unassorted. Below this the materials are cross-bedded or stratified coarse gravel, sand, and fine sand. Most of the gravel is from sandstone, but some is from quartzite, schist, granite, chert, and shale. The thickness of the various layers varies considerably. Drainage is good, mostly internal, and in places excessive.

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This soil occurs in the valleys of Basher Kill and Shawangunk Kill in association with Chenango gravelly sandy loam. In all, about 4 square miles is mapped.

Chenango gravelly loam is used for the production of most of the crops commonly grown in the county—corn, oats, hay, buckwheat, and pasture. Moderately high yields of most crops are obtained under good management. Corn yields from 12 to 15 tons of silage and 40 to 50 bushels of grain to the acre, oats 40 to 50 bushels, timothy and clover or sweetclover 1½ to 2 tons, timothy and alfalfa 1¾ to 2½ tons, and timothy alone 1¼ to 1¾ tons. Buckwheat, which is occasionally grown, yields 25 to 30 bushels. Potatoes yield from 150 to 175 bushels an acre. About 20 percent of the land is idle and at present is very much run down. About 6 percent remains in forest, 10 percent is pastured, 15 percent is in corn, 10 percent in oats, 35 percent in hay, and 4 percent in vegetables or in residential areas.

Rotations are rather irregular in this area, but usually a 6-year rotation is followed. Corn may be followed by potatoes or, more usually, by oats, and this, in turn, by 3 or 4 years of hay. From 10 to 12 tons of manure and 300 to 500 pounds of superphosphate to the acre are applied on land prepared for corn, and 1 to 1½ tons of lime on land prepared for oats and seeding. Top dressings of manure are frequently applied on meadows after the second season if the hay crop is to be maintained for 4 years or longer.

Forested areas support red maple, sugar maple, sassafras, pitch pine, red oak, hickory, and aspen. Sumac and aspen readily invade idle fields.

Pastures on this soil are generally neglected and are only fair to poor. Bluegrass, timothy, and wild white clover are the most desirable grasses and are mixed with varying percentages, up to 50 percent in many pastures, of weeds, sorrel, foxtail (*Setaria lutescens*), plantain, ragweed, devils-paintbrush, and goldenrod.

Chenango gravelly sandy loam.—This soil is not so intensively used as Chenango gravelly loam, as it is less productive. The two soils are closely associated and are equally well suited to the use of farm machinery. Chenango gravelly sandy loam is more porous and leachy, however, and therefore is more readily affected by drought.

The surface soil of Chenango gravelly sandy loam is light brownish gray to pale brown, mellow and without well-defined structure. In places the texture ranges from gravelly sandy loam to gravelly fine sandy loam. Between depths of 9 and 22 inches the subsoil is pale-brown gravelly sand or fine sandy loam. This is rather firm in place but friable and structureless. Below this, the subsoil is very pale brown firm gravelly sandy loam that is mellow, single-grained, and structureless. Below a depth of 45 inches the soil material is loose and consists of cross-bedded and stratified gravel, coarse sand, pebbles, and fine sand. The gravel throughout is mostly from sandstone mixed with a varying amount of quartz, chert, red sandstone, granites, and gneiss gravel. In a deep exposure lime-coated calcareous sandstone and limestone gravel was observed 11 feet below the surface.

This soil is mapped only in the valleys of Basher Kill and Shawangunk Kill, where it covers 2.6 square miles.

Nearly 30 percent of the land is forested, and at least 15 percent is idle. The remaining 55 percent is farmed, 10 percent being used for pasture, 12 percent for corn, 8 percent for oats, and about 25 percent for hay. Under present management average yields are only moderate. Corn for silage yields from 9 to 12 tons an acre, oats 35 to 40 bushels, timothy and clover 1¼ to 1¾ tons, timothy, clover, and alfalfa 1½ to 1¾ tons, and timothy alone 1¼ to 1½ tons.

Usually a 6-year rotation is followed, but the rotation is varied considerably. Corn and oats are followed by hay in rotation. Hay crops are maintained from 3 to 5 years, and usually after the third year they are pretty well run out. From 10 to 12 tons of manure and about 300 pounds of superphosphate are applied on cornland, and 1 or 1½ tons of lime is applied to land prepared for seeding to hay crops. Hay mixtures of timothy and red clover or timothy, red clover, and alfalfa are planted. On the better farms top dressings of manure and phosphates are used on the hay land to improve and prolong the meadows. This soil is naturally droughty; however, with the incorporation of sufficient manure the moisture-retention capacity can be increased.

Pastures on this soil are neglected and poor. The percentage of desirable pasture grasses is very low. Poverty oatgrass, sorrel, dewberries, goldenrod, devils-paintbrush, yarrow, and spirea grow most abundantly.

Forests on this type include gray birch, sugar maple, white ash, hickory, red maple, white pine, and red and white oak. Gray birch and aspen gradually encroach on idle areas. The idle areas support mostly weeds, broomsedge, and dewberries.

Otisville gravelly sandy loam.—Because of its hummocky relief, this soil is difficult to work, and a large part of it is idle, forested, or pastured. It is not productive, as the water table lies at a great depth and the substratum is very loose and porous. The soil occupies small knolls and winding mounds. The relief is not so rough as that of Otisville gravelly loam.

To a depth of 7 inches, the surface soil is pale brown to weak brown, loose, single-grained, and porous. The upper subsoil layer is yellowish-brown pebbly, porous sandy loam. Between depths of 24 and 60 inches the subsoil is yellowish-brown loose porous gravelly sand. Below this the soil materials are cross-bedded and stratified gravel and coarse and fine sand. The gravel is derived from sandstone shale, quartz, granites, chert, and sandstone conglomerate.

The soil occurs in the valleys of Basher Kill and Shawangunk Kill. The total area is 3.6 square miles.

The relief varies considerably. Although irregular and uneven, about 50 percent of the area is not so rough as most areas of the other Otisville soil. The slope averages about 12 percent and ranges from 8 to 25 percent. Drainage is rapid and mostly internal.

About 20 percent of the land is forested, 23 percent is idle, 15 percent is pastured, 10 percent is in corn, 7 percent is in small grain, and 25 percent is in hay. Yields on this type vary considerably with the care the soil receives. Average yields are much lower than those obtained where the soils are carefully managed. The average yield for silage corn is about 8 tons an acre, oats about 30 bushels, and hay ¾ to 1½ tons.

About 40 percent of the cultivated area is intensively worked and carefully handled. A 4- or 5-year rotation is followed, and the land heavily manured. Cover crops are grown and turned under frequently. From 12 to 14 tons of manure and 300 to 400 pounds of superphosphate are applied on cornland. From 1 to 1½ tons of lime is applied on the land prepared for oats and seeding. Mixtures of timothy and red clover or timothy, red clover, and alfalfa are commonly seeded; birdsfoot trefoil could be used to good advantage. Top dressings of manure are applied on the meadows. With care, fair hay crops can be obtained from this soil for a third season. The meadows are sometimes pastured the third season and are frequently pastured one season each year after the third year of hay.

The pastures on the better managed areas are fair to good. Timothy, red clover, wild white clover, and Kentucky bluegrass grow in fair percentages. Some weeds occur in all pastures. Most of the pastures are poor and neglected, contain an abundance of weeds, and support a sparse growth of good pasture grasses.

The forests include red, white, and chestnut oaks, shagbark hickory, white ash, red maple, sugar maple, and popple. Idle areas are mostly weedy, but aspen and sumac encroach fairly rapidly.

Otisville gravelly loam.—Most areas of this soil are forested. They are rougher and steeper than those of Otisville gravelly sandy loam and are not suitable for cultivation. Though neglected, pastures are generally better than those on the other Otisville soil. Birdsfoot trefoil is deep-rooted and should improve pastures in this droughty soil if well fertilized and limed.

The surface soil, to a depth of 6 inches, is pale-brown gravelly loam having a granular structure. This is underlain by an upper subsoil layer of weak-brown mellow light gravelly loam to very fine sandy loam. Between depths of 12 and 24 inches the subsoil is light yellowish-brown mellow gravelly very fine sandy loam. Below this the subsoil is gray and yellow gravelly sandy loam that is loose and open in structure. Beginning at a depth of 32 inches the material is light olive-gray very fine loamy sand that is loose, porous, and structureless. The porous, loose, and structureless materials below a depth of 50 inches consist of cross-bedded or stratified gravelly coarse sand, gravelly sand, and fine sand. The gravel is derived from sandstone, quartz conglomerate, granite, gneiss, shale, and chert.

The soil occurs principally in the valley of Basher Kill on isolated kames and kame terraces along the sides of the valley in close association with the Chenango soils. A few areas also occur in the valley of Shawangunk Kill. About 2.5 square miles is mapped.

The slope of this soil is steeper than that of Otisville gravelly sandy loam, ranging from 12 to 30 percent and averaging about 18 percent. Drainage is good and mostly internal. Sheet erosion is severe in many pastured areas and on idle land where the cover is thin and weedy and the slope is steep.

Although this soil has a slightly better moisture-holding capacity than Otisville gravelly sandy loam and supports slightly better pasture, the soil is mostly idle and forested. About 45 percent of the land is forested, 30 percent is idle, slightly more than 20 percent is pastured, and less than 5 percent is cultivated. Most of the pastures on this soil are poor, but they include some Kentucky bluegrass, wild white

clover, timothy, and foxtail. There are many barren areas in the pastures, and weeds such as goldenrod, mullein, ragweed, wild carrot, and aster grow abundantly.

The forests on this soil include yellow birch, red maple, sugar maple, shagbark hickory, pin cherry, red oak, white oak, white ash, white pine, and basswood. On abandoned areas that have reverted to forest the stands include mostly aspen (popple), gray birch, and pin cherry, and some young oak, white pine, and sugar maple trees. The many idle areas are weedy; where they have been idle for some time the cover consists of sumac, briers, and other brush.

Braceville silt loam.—This type is closely associated with the Chenango soils, from which it differs in being slightly heavier textured and imperfectly drained. It supports better pastures and hay than the Chenango soils, because it retains moisture better in dry periods. A large part of the land is in hay or pasture.

The 9-inch surface soil is pale-brown silt loam, massive in form, and contains some rounded gravel. This rests on an upper subsoil layer of light yellowish-brown gritty silt loam that is slightly marbled with dark brown and gray in the lower part. Between depths of 21 and 36 inches the lower subsoil layer is light olive-gray gritty gravelly silt loam mottled with gray and dark brown. Below this the deep substratum is stratified light olive-gray to medium-gray fine sand, silt, and gravel streaked with dusky-yellow and rust-brown stains. The soil is medium acid throughout. Drainage is imperfect, although mostly internal. The lower subsoil layer is only moderately impervious.

Included with this soil is an area of 150 to 200 acres near Burlingham in which the soil is developed from lake-laid deposits and consists of laminated very fine sand and silt. Drainage is imperfect, and some gravel is present. This inclusion resembles the imperfectly drained Hudson soils mapped in Ulster County, and if the area of this soil were extensive enough it would be separated from Braceville silt loam.

An area of only 1.3 square miles is mapped, chiefly near the villages of Wurtsboro and Bloomingburg.

About 50 percent of the land is in hay crops, 45 percent is pastured, and the remaining 5 percent is idle or forested. Mixed timothy, alsike clover, and red clover is the principal hay crop, but Ladino clover would be a better legume because it tolerates imperfect drainage as well and is long-lived. One owner estimates average yields at 1½ to 2 tons an acre. Pastures on this type, although generally neglected, contain fair to good percentages of Kentucky bluegrass, wild white clover, and timothy, which are mixed with poverty oatgrass, yarrow, buttercup, and dandelion. Treatments of lime and phosphate produced an excellent turf in one small pasture. Forested areas on this soil include elm, ash, shagbark hickory, red maple, and yellow birch, and all of them are small.

SOILS OF THE FIRST BOTTOMS

The soils of the first bottoms are more or less subject to overflow during the higher stages of the streams, and at such time some additional sediments are usually deposited. Most of the soil materials have been washed from the adjacent uplands during a long period

of years. They consist largely of materials derived from sandstone and shale, which are naturally acid in reaction; therefore the alluvium from this source is also acid.

Small areas or long narrow belts of these alluvial deposits border the major streams and their larger tributaries through the county. No large broad belts are developed along streams as in other parts of the State, as the valleys are comparatively narrow throughout the county. These soils occupy about 3 percent of the total area of the county.

The well-drained soils of the bottoms are members of the Barbour series; the moderately well drained to imperfectly drained soils are members of the Basher series; and the low-lying and imperfectly to poorly drained soils are members of the Holly and Wallkill series.

The Barbour series includes acid recent alluvial deposits washed from areas of red shale or red glacial till. They occur along the streams draining the plateau area of the county and are formed from deposits composed principally of red sandstone and shale mixed with some gray sandstone. They have a weak-brown or brownish-gray surface soil, weak-red upper subsoil deeper layer, and a reddish gray lower subsoil layer. Internal drainage is good, even though the surface is flat. Variations within the series are mostly in the color and the amount of gravel or coarse material in the subsoil. The color is brightest where the materials are almost pure red shale and sandstone and lightest where the admixture of gray sandstones and shale is greatest. Flooding may occur in periods of very heavy rains and spring freshets. These are the most intensively used soils of the first bottoms and are used in the production of nearly all the crops grown in the county. A few areas scattered throughout the county are used for the production of truck crops.

Four types, Barbour fine sandy loam, Barbour silt loam, Barbour loamy sand, and Barbour gravelly loam, are mapped in this series. A high-bottom phase of the fine sandy loam, a gravel-substratum phase of the loamy sand, and an alluvial-fan phase of the gravelly loam are also separated.

The Basher series includes imperfectly drained recent alluvial deposits. Only one type, Basher silt loam, is mapped. In the valleys of the plateau area the soil is formed from gray and red sandstone materials and differs to a slight extent in color from the soil occurring in the southeastern part of the county, which is formed from gray sandstone and gray shale. The soil has a brownish-gray or light brownish-gray surface soil over a yellowish-brown upper subsoil layer and a strongly mottled gray heavy deep subsoil layer. The land is flat. Bodies of this soil occupy a small total area, and most of them are in pasture.

The Holly series includes imperfectly to poorly drained alluvial deposits of red and grayish-brown acid soil materials. Only one soil is mapped in this county. It represents a complex of recent alluvial soils derived from wash from the plateau area of red and gray sandstone and shale and recent alluvial soils derived from wash from slate, quartz, and gray sandstone areas on the Shawangunk Mountain. Drainage is imperfect to poor, but the soil is not permanently wet. Small areas are only imperfectly drained, but the separation was not justified. The land is subject to overflow and has a flat

relief. The color ranges from dark reddish gray in the red shale areas to mottled yellowish brown and gray in the gray sandstone and shale areas of the county. The soil is used mostly for pasture.

The Wallkill series includes recent alluvium and organic deposits of gray soil wash interstratified with muck or peaty organic materials washed from the gray sandstone and shale areas of the adjacent uplands and deposited around the edges of muck areas where small streams enter the swamp in the valley of Basher Kill. One type, Wallkill silt loam, is mapped. Areas of this soil are flat to depressed, and the soil is permanently wet.

Barbour fine sandy loam.—This is the most extensive soil of the Barbour series. There are more large unit areas of this type than of any other type in the series, and where it occurs in large units it is intensively farmed. It is used principally in the production of crops in support of dairying.

The surface soil is brown to brownish-gray mellow fine sandy loam, about 6 inches deep. The upper subsoil layer is weak-red or yellowish-brown friable fine sandy loam. Between depths of 12 and 26 inches the subsoil is fine sand to very fine sand, firm in place. The deeper subsoil layer consists of reddish-gray fine to very fine sandy loam that is slightly compact in place but friable in hand and structureless. Below a depth of 40 inches the materials are somewhat stratified coarse sand, small gravel, and cobblestones. The sand and gravel materials are composed of quartz, red and gray sandstones, and red shale. The reaction is medium acid throughout. Drainage is good. The soils vary considerably in color. Where the alluvium is derived mostly from areas of red soil the upper layers are more red than elsewhere.

Barbour fine sandy loam occurs principally on the first bottoms along the larger streams, especially the Delaware and Neversink Rivers, Little Beaver Kill, and Willowemoc Creek. Smaller areas border the minor tributaries of these streams. A few of the larger areas include from 200 to 250 acres each. The aggregate area of this soil is 10.4 square miles.

About 90 percent of the land is cultivated or pastured, and 10 percent is idle or forested. There are but few permanent pastures. In general, the soils of the bottom lands are the most easily worked soils on the farm, and in many places they are more productive than the soils of the adjacent uplands. Therefore, not more than 5 percent of the land is regularly pastured. About 55 percent of it is in hay crops, 15 percent in corn, 12 percent in oats, and 3 percent in vegetable crops. Overflow may occur, but usually during spring freshets, so that crops are seldom completely lost. Corn for silage yields 12 to 16 tons an acre, oats 40 to 50 bushels, timothy and red clover hay 1¾ to 2 tons, timothy, red clover, and alfalfa 1¾ to 2½ tons, and timothy alone 1½ to 2 tons.

Crop rotations vary considerably on this soil. Manure is applied on the ground prepared for corn at the rate of 8 to 10 tons an acre. From 200 to 250 pounds of 16- or 20-percent superphosphate is also applied with the manure on cornland. From 1 to 1½ tons of lime is applied at the time the ground is prepared for oats and seeding. Meadows are maintained from 3 to 4 years. The soil is sometimes affected by drought in very dry summers. If the meadows are poor,

top dressings of manure are applied. Sometimes meadows are pastured for 1 year before being plowed for corn. Vegetables, chiefly sweet corn, tomatoes, and cabbage, are sometimes grown 1 year in the rotation, either before corn or after.

Native pastures on this soil are only fair. They contain some wild white clover, Kentucky bluegrass, poverty oatgrass, and timothy, but weeds are abundant. Meadows that are used for pasture after the hay crop has run out furnish the best pasture land. They are seldom used more than one or two seasons for pasture, however, before they are plowed again for cornland or cultivated crops.

The areas of Barbour fine sandy loam that are idle or forested are generally small ones that are isolated from other desirable and arable soils or occur in reserve and recreational areas. The few forested areas include white pine, red maple, elm, ash, birch, and aspen.

Barbour fine sandy loam, high-bottom phase.—This phase is similar to the normal phase, but it lies above the level of normal overflow and receives little deposition from this source. The surface soil is lighter colored, but the lower subsoil layer is about the same as the corresponding layer of the normal phase.

Soil of this phase occurs only along the larger streams, principally along the Delaware and Neversink Rivers. The crops grown on this soil are practically the same as those on the normal phase. Slightly higher applications of fertilizers and manure are used on this soil, but the yields of crops are about the same as on normal Barbour fine sandy loam.

Barbour silt loam.—This is the most fertile and most productive soil of the bottom lands in this county. Where it occurs in large enough units, it is intensively farmed.

The 9-inch surface layer is dark reddish-gray friable silt loam having a fine granular structure. This rests on an upper subsoil layer of weak-red silt loam that is firm in place but friable. Between depths of 18 and 28 inches the subsoil is weak-red friable silt loam to light silt loam containing lenses of sand. The lower part of the subsoil consists of alternate strata of red silt and sandy loam. Below a depth of 40 inches the gravel, silt, and sand materials are stratified. The gravel is principally of red shale and sandstone mixed with some gray sandstone and conglomerate. The reaction is medium acid throughout. Drainage is good, and internal drainage is not so rapid or excessive as it is in the lighter textured soils of this series.

Barbour silt loam occurs in one large area and several small units. The large area on Beaver Kill at Rockland probably does not include more than 185 acres, but it is most intensively farmed. The small areas are scattered along the Neversink River and Willowemoc Creek. In all, 1.4 square miles are mapped.

Almost all of this land is farmed and used in the production of corn, oats, hay, and vegetables. About 5 percent is used for vegetable crops, 15 percent for corn, and 15 percent for oats; the rest is used for hay crops. Corn for silage yields 15 to 16 tons an acre, oats 45 to 55 bushels, timothy and red clover hay 2 to 2½ tons, timothy, red clover, and alfalfa 2¼ to 3 tons, and timothy alone about 2 tons.

Rotations vary on these soils, but a 5- or 6-year rotation is generally practiced. Corn for 1 year is followed by oats seeded with hay, and the hay crops are maintained for 3 or 4 years. Light applications

of manure and phosphates are applied on the cornland, and from 1 to 1½ tons of lime is applied for oats. Oats are frequently cut green, as they tend to lodge. Vegetable crops include sweet corn, cabbage, tomatoes, beets, peas, and carrots.

This soil is occasionally flooded. Although floods cause some damage to hay crops, losses of other crops are not frequent, as most of the overflows occur in spring before the crops are planted.

Barbour loamy sand.—This is a more open and leachy soil than Barbour silt loam or Barbour fine sandy loam. It is rather intensively farmed, but it requires more careful management and heavier fertilization than do those soils. Yields are slightly lower, except where the land is heavily fertilized. The soil occurs along the valleys of the major streams and is subject to overflow.

The 8-inch surface soil of Barbour loamy sand is weak brown, loose, and structureless. In places the texture approaches loamy fine sand. The upper part of the subsoil is pale-brown to weak-red loose single-grained fine sand. Between depths of 24 and 30 inches the subsoil is firmer than the material in the layers above and consists of weak-red very fine sand to light silt. Below this the materials are stratified sand and gravel of parent rock materials resembling those common to the other soils of the series. The reaction is moderately to strongly acid throughout. Drainage is mostly internal and excessive.

The larger areas are in the northern part of the county along Rondout Creek, the Neversink River, and Willowemoc Creek. Smaller areas are scattered along other streams. A total area of 2.3 square miles is mapped. Included with this type are one or two areas lying above the level of normal overflow. This inclusion is really a high-bottom phase. The largest area of this inclusion is about 1 mile northeast of Willowemoc, along Willowemoc Creek. It is managed about the same as the normal soil.

Barbour fine sandy loam is used for the production of corn, oats, hay, and pasture. Probably 5 percent of the total area is idle, 15 percent is pastured, 15 percent is in corn, 10 percent in oats, and the rest in hay. Mixed timothy and red clover, and timothy, red clover, and alfalfa are most commonly grown. Timothy and mammoth clover are seeded by a few farmers. Average yields are lower than those on the other soils of this series. Corn yields 8 to 10 tons of silage an acre, oats 25 to 35 bushels, timothy and red clover 1¼ to 1¾ tons, and timothy, red clover, and alfalfa slightly more. Timothy and mammoth clover yield about 2 tons. By careful management and heavier applications of fertilizer the yields on the better farms are greatly increased and about equal those obtained on Barbour fine sandy loam.

Manure is applied on the cornland at the rate of 10 to 12 tons to the acre with 200 to 300 pounds of superphosphate. About 1 ton an acre of lime is applied on the soils prepared for oats and seeding. Hay land is commonly top-dressed with manure. Rotations range from 4 to 5 years. Meadows are sometimes pastured the third year.

Native pastures on this soil are poor. Timothy, poverty oatgrass, sweet vernalgrass, some Kentucky bluegrass, and wild white clover can be found in most pastures. Weeds in places are in greater abundance than the desirable pasture grasses. Mullein, wild straw-

berry, dewberry, aster, devils-paintbrush, daisy, and wild carrot are the commonest weeds.

Barbour loamy sand, gravel-substratum phase.—This phase occurs chiefly in the northern part of the county. It is shallow over coarse gravel and large cobblestones and is a very poor and low productive soil. It is used principally for pasture, and some areas are idle. The soil is very droughty; pastures are poor and usually suffer severely in the summer.

The surface soil is reddish-gray loose loamy sand, about 6 inches deep. This is underlain by subsoil materials of pinkish or weak-red coarse sand and small gravel. Below a depth of 18 inches the materials consist of loose coarse sand, cobbles, and gravel. The gravel is derived from red and gray sandstones, red shale, quartz, and conglomerate rocks. The reaction is strongly acid, and drainage is good or excessive.

In many places this soil lies somewhat lower than the other soils of the bottom lands, especially at the bends of the principal streams where the waters are rapid and during high periods frequently overflow. Other areas occur where smaller streams having high gradients enter the larger streams. Small areas are distributed along most of the larger streams of the county. The largest ones are along the upper reaches of the Neversink River and near Unionville, Parkston, and Lewbeach. The total area is about 2.1 square miles.

The native pastures on this soil are poor. No treatment is given to them, and weeds are generally more abundant than the desirable grasses. Pastures include timothy, bluegrass, poverty oatgrass, goldenrod, devils-paintbrush, wild carrot, aster, and dewberry. Sumac, elm, white ash, cottonwood, butternut, sugar maple, and white pine trees occur in pastures and idle areas of this soil.

Barbour gravelly loam.—This soil occurs along the streams, closely associated with the other Barbour soils. It occurs in small units, however, and in many places its use is determined by the adjacent soils. It is as productive a soil as Barbour fine sandy loam, and where it occurs in sufficiently large units to be farmed it is managed in much the same manner as that soil, except that applications of manure are perhaps slightly lighter.

The 8-inch surface soil is weak-brown loam mixed with slightly rounded sandstone and shale gravel. The upper part of the subsoil is weak-red firm moderately heavy but gravelly loam. Between depths of 19 and 32 inches the lower subsoil layer is reddish-gray loose gravelly loam. The soil materials below consist of somewhat stratified or cross-bedded gravel, coarse sand, and very fine sandy loam.

Very small areas of this soil border many of the streams. One of the largest ones south of Fremont Center probably includes 50 or 55 acres. The aggregate area of this type is 1.2 square miles.

About 25 percent of the land is cultivated, 50 percent is pastured, and the rest is idle. Corn, oats, and hay are the principal crops. Mixed timothy and clover is the commonest hay crop. Judging from the appearance of crops on this soil, it is fully as productive as Barbour fine sandy loam. In many places it adjoins soils that are suitable only for pasture, and about 50 percent of such land is so used. Pas-

tures are fair to good, generally supporting wild white clover, Kentucky bluegrass, timothy, and bentgrass in fair quantities.

Barbour gravelly loam, alluvial-fan phase.—The surface soil of this phase is similar in texture to that of Barbour gravelly loam; otherwise it is variable. The soil of this phase occurs in triangular areas at the mouths of smaller streams, where overflow water has spread outwash materials in the valleys. These areas lie somewhat higher than the general level of the bottoms and slope toward the trunk streams.

Soil profiles are so variable on these fans that no one could be called typical. Although the texture of the surface layers varies considerably, it is generally loam. The subsoil generally consists of light loam mixed with a varying quantity of gravel and large cobblestones. Coarser materials are present at the heads of the fans, and progressively finer materials have generally been deposited toward the outer edges of the fans. This soil is acid in reaction throughout, and it is open and porous. Drainage is mostly internal and generally excessive. Except in a few areas where stream channels have been dug deeper, this soil is subject to overflow, especially in spring. Fresh deposits of overwash are left by the flooding.

The soil is widely distributed throughout the county at the junction of many of the small streams with larger ones. Most of the areas are small—from 5 to 15 acres. One of the largest areas occurs in Long Eddy, where the creek bed has been deepened. A total area of 1.7 square miles is mapped.

Only about 10 percent of this land is cultivated. Moderate yields of corn, oats, and hay are obtained. Soil treatments and rotations are generally the same as those used on the larger adjacent areas of soils. About 50 percent of the land is pastured, and the rest is idle. Pastures generally are only fair on this type and are frequently affected by drought in the driest summer months.

Basher silt loam.—This soil occurs in small scattered areas and is used mostly for pasture, to which it is well adapted.

The surface soil to a depth of 8 inches is brownish gray and somewhat granular. The upper part of the subsoil is pale-brown silt loam that is firm in place but friable. Between depths of 15 and 24 inches the subsoil is moderately mottled, yellowish-brown, firm to slightly compact silt loam. The deeper part of the subsoil is gray silty clay loam strongly mottled with yellow and rusty brown. Areas along the bottoms in the areas of red soil have a reddish cast in the lower layers, but other soil characteristics are similar. The reaction is medium acid throughout. Drainage is mostly internal and slow or imperfect, as the lower layers are only slowly pervious. Along East Branch Callicoon Creek south of Youngsville a soil having a sandy surface texture is included with this soil.

Small areas occur along the tributaries of Callicoon Creek and along Shawangunk Kill, Basher Kill, and other streams. The total area is only 1.9 square miles.

The soil is used principally for pasture and supports fair to good stands of timothy, bentgrass, wild white clover, and Kentucky bluegrass. A few areas are used for hay crops and yield from 1¾ to 2 tons of timothy and red clover.

Holly silt loam.—This is a poorly drained soil of the first bottoms. It occupies wet situations near the streams and is subject to frequent overflow. Most areas are developed along the sluggish small streams in the county. Where used at all the soil is pastured, but many areas are idle.

As mapped in this county, Holly silt loam is really a complex of Holly silt loam and Basher silt loam. Typically the Holly and Basher soils are developed from gray sandstone and shale materials and do not contain much red shale and sandstone materials. As mapped, however, Holly silt loam includes soils that are typical of neither series, but the agricultural usefulness is about the same as that of typical Holly and Basher soils.

The surface soil to a depth of 9 inches is very dusky brown silt loam. Under sod the soil is granular and contains a considerable quantity of organic matter. In many places the lower few inches of the surface soil is streaked with yellow and rust brown. Penetration of roots is confined mostly to this layer. The upper part of the subsoil is yellowish-brown heavy silt loam strongly mottled with gray and dark brown. Between depths of 16 and 26 inches the subsoil is yellowish-brown silty clay loam strongly mottled gray and rust brown. Below this and reaching to a depth of 48 inches or more the deep subsoil is medium-gray silty clay loam strongly mottled with dark brown. The reaction is medium to strongly acid throughout. The natural water table is high in these soils, and both surface and internal drainage are poor. The land is flat and in some places depressed. In many areas where the soil is more like a Holly-Basher complex, slightly higher small knolls of a better drained soil are surrounded by the depressed areas of permanently wet soil.

The largest bodies of Holly silt loam border Basher Kill, which in Sullivan County is a very sluggish stream. Other fairly large bodies occur at the head of Swan Lake and small streams near Mongaup Valley, Monticello, and Liberty. Because of its small extent, an area of artificial fill (made land) just east of Hurleyville, which is southeast of Liberty, is shown on the map as Holly silt loam. A total of 12 square miles is included on the map.

The land is used principally for pasture, as it is too wet for cultivation and drainage is impracticable. Native pastures are fair to poor. Bluegrass, wild white clover, redtop, and timothy grow in most pastures. Pastures on this land are generally neglected, however, and hardhack, small brush, and coarse reeds crowd the more desirable pasture grasses. On idle areas and in the poorer pastures elm, red maple, silver maple, and black ash are encroaching.

Wallkill silt loam.—This soil occupies low, flat, poorly drained areas and consists essentially of silty alluvium over peat or muck. In its present condition it has no agricultural value and supports a forest cover.

The 8-inch surface soil is black highly organic silt loam. The upper part of the subsoil is black muck containing thin lenses of silt. Between depths of 16 and 30 inches the subsoil consists of stratified silt and muck. Below this the deep material is dark brown somewhat decomposed peat. The reaction is acid throughout.

The native vegetation consists of elm, red and silver maples, willow, alder, swamp grasses, and water-loving shrubs. The soil has never been cultivated.

MISCELLANEOUS SOILS AND LAND TYPES

Miscellaneous soils and land types occupy a fairly large area, representing about 15 percent of the total area of the county. Rough mountainous land and rough stony land are the most extensive land types in this group. Smooth stony land (Catskill soil material), alluvial soils, undifferentiated, riverwash, and peat are also included. Most of the land in this group is forested or idle. A few areas of the smooth stony land (Catskill soil material) and of the alluvial soils, undifferentiated, are pastured. One small area of peat has been cleared and drained and is used for crops.

Rough mountainous land.—An aggregate area of 63 square miles of rough mountainous land is mapped. It includes very rough dominantly stony land together with small areas of soil that, if cleared of forest, would be suitable for crops or pasture, and some stony areas that are suitable for grazing. Such areas consist of the Lackawanna and Catskill soils. Most of the arable areas, however, are small and inaccessible. In the southeastern part of the county large areas of stony soils and smaller associated areas of arable soils developed from Shawangunk conglomerate materials are included. The soil mantle is relatively thin in this area, and outcrops are numerous. Practically all of this inclusion is forested. A few areas in the northern part of the county within the Catskill Forest Preserve were at one time partly cleared but are now reforested.

Rough stony land.—This classification includes land that is too steep or stony or is otherwise unsuitable for either cropping or grazing. The land is very steep and includes many outcrops, rock ledges, cliffs, and large boulders. Where present, the soil mantle is very thin and includes very shallow soils developed from red shale and sandstones, gray sandstone, and sandstone conglomerate or Shawangunk conglomerate. This land type is well distributed throughout the county and occurs mostly along the steep valley slopes or gorges of the major streams. Forests grow wherever the soil is sufficiently deep to support growth. An area of 43.5 square miles is mapped.

Smooth stony land (Catskill soil material).—This type includes land that, like rough stony land, is shallow and stony but has a smoother or nearly level surface. In this county it consists of sandstone outcrops and boulders of the Catskill formation, and a small amount of soil material. It covers about 7 square miles. Most of it is forested or barren.

Alluvial soils, undifferentiated.—These soils are mapped along small streams in all parts of the county. They consist of mixed soils of no definite texture and in most places are imperfectly or poorly drained. Small spots of practically all of the soils found in the bottom lands are included. Some soils are included that receive wash from areas of red shale and gray sandstone, gray sandstone and conglomerate, Shawangunk conglomerate, and Hudson shale. The reaction is everywhere acid. In places the material contains a considerable

quantity of stones; in other places it contains much gravel; and small areas consist of heavy silts or muck. In all 17.7 square miles is mapped.

About half of this bottom land is cleared and used for mowing or pasture. Many areas are covered with alder, willow, ferns, and other water-loving vegetation. Owing to the mixed character of this soil material, its value for the production of crops is extremely variable, most of it being of little value except for grass and in a few favored spots for corn and oats.

Riverwash.—Riverwash includes recently deposited stony, gravelly, and sandy materials that are subject to frequent moving in high waters and flood stages. The soil materials are coarse and porous and generally barren. The land is useless for plants and has no agricultural value. Riverwash is most extensive along the Neversink River in the northern part of the county. Only 576 acres is mapped.

Peat.—Numerous small areas of peat are rather widely distributed throughout Sullivan County. There are woody, fibrous woody, and fibrous peat areas in the county. The most extensive peat area, containing a fibrous peat, occurs in the valley of Basher Kill. It extends along the valley for 5½ miles from just south of Wurtsboro almost to the Orange County line. The area varies in width, being about three-eighths of a mile at its widest point. Table 6 gives an analysis of the peat in this area. Other smaller areas occur in this same valley north of Wurtsboro.

TABLE 6.—*Analysis of peat near Wurtsboro in Sullivan County, N. Y.*[1]

Depth, inches	Description	Organic matter	pH
		Percent	
0–18	Fibrous, more or less compact	77 0	5 0
18–24	Fibrous, very compact	66 3	5 4
60–66	....do		5 8
72–84	Largely clay and sand		6 1

[1] By Dr B D Wilson, professor of soil technology, Agronomy Department, New York State College of Agriculture

The material analyzed was a fibrous peat derived largely from the debris of reeds and sedges. This is not a first-class peat deposit for agricultural purposes.

Only one area of fibrous woody peat, about 1 mile east of Monticello, has been drained and is used for agricultural purposes. Crops have not been very successful on this type, and table 7 gives an analysis of the soil.

TABLE 7.—*Analysis of fibrous woody peat near Monticello in Sullivan County, N. Y.*[1]

Depth, inches	Description	Organic matter	Absorptive capacity	pH
		Percent	*Percent*	
0–9	Well decomposed fibrous woody peat	83 7	313	4 4
9–20	....do	84 2	336	4 1
20–26	Largely fibrous but some sedimentary peat	93 0		4 0
26–90	Largely fibrous containing more sedimentary peat	96 0		4 2

[1] By B. D. Wilson.

The analysis shows the soil to be high in organic matter, low in water-holding capacity, and very strongly acid in reaction. This can be used as an agricultural soil provided adequate drainage can be established and maintained and if the land is properly fertilized for the crops grown.

In the southwestern part of the county, south of the Newburgh and Cochecton turnpike and west of the Neversink River Valley, are many bogs and swamps containing mainly fibrous peat. These areas vary in size from a few acres to 300 or more. Deep Hollow Swamp in the southern part of Tusten and the three or four swamps northeast of Woodbourne and east of Hasbrouck are mostly woody peat. The total area of peat is 11.5 square miles.

PRODUCTIVITY RATINGS

In table 8 the soils of Sullivan County are listed alphabetically and estimated average acre yields of the principal crops are given for each soil under the prevailing farming practices. The type of farming, principal crops, and use made of each soil are given in the right-hand column of the table.

The estimates in table 8 are based primarily on interviews with farmers, although they have been checked somewhat with the county agricultural agent, members of the staffs of the Cornell University Agricultural Experiment Station and the New York College of Agriculture, and others who have had experience in the agriculture of this county. They are presented as estimates of the average production over a period of years according to the prevailing type of farming. It is realized that these estimates may not apply directly to specific tracts of land for any particular year, as the soils vary somewhat, management practices differ slightly, and climatic conditions fluctuate from year to year. On the other hand these estimates appear to be as accurate information as can be obtained without further detailed and lengthy investigations, and they serve to bring out the relative productivity of the soils shown on the map.

In order to compare directly the yields obtained in Sullivan County with those obtained in other parts of the country, estimates of yields have been converted in table 9 to indexes based on standard yields. The soils are listed in the approximate order of their general productivity under prevailing farming practices, the most productive first.

The rating compares the productivity of each of the soils for each crop to a standard of 100. This standard index represents the approximate average acre yield obtained without the use of amendments on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as is the soil with the standard index. The standard yield for each crop shown in table 9 is given at the head of each respective column. Soils given amendments, such as lime and commercial fertilizers, or special practices, such as irrigation, and unusually productive soils of small extent, may have productivity indexes of more than 100 for some crops. The indexes for pasture are probably less satisfactory than those for the specified crops.

TABLE 8.—*Estimated acre yields of the more important crops on the soils of Sullivan County, N. Y., management* [1]

Soil	Corn silage	Oats	Buckwheat	Timothy	Mixed timothy and red clover	Red clover	Mixed timothy and alsike clover	Mixed alfalfa and timothy	Potatoes
	Tons	*Bushels*	*Bushels*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Bushels*
Alluvial soils, undifferentiated				1.00					
Barbour fine sandy loam	14	45		1 75	2 00	2.25		2 50	
High-bottom phase	14	45		1 75	2 00	2.25		2.50	
Barbour gravelly loam	14	40		1 75	2 00	2.00		2 25	
Alluvial-fan phase	12	35		1 50	1 50	1 50		2.00	
Barbour loamy sand	8	25		1 00	1 50	1 50		1 75	
Gravel-substratum phase									
Barbour silt loam	16	50		2.00	2 50	2.50		2.50	
Basher silt loam	9	30		1 00	[2] 1 50		1 75		
Braceville silt loam	8	30		1.00	[2] 1.50		1.75		
Catskill loam	10	45	18	1 25	1.50	1.75		2.00	17
Catskill sandy loam	8	25		75	1 25				
Catskill silt loam	12	45	20	1.25	1 50	1 75		2 00	17
Catskill stony loam									
Catskill stony sandy loam									
Catskill stony silt loam									
Chenango gravelly loam	13	45	25	1 50	1.75	2.00		2.25	
Chenango gravelly sandy loam	10	30	15	1 25	1 50			2.00	
Colchester gravelly loam		25		1 00	1 25				
Colchester loamy sand				.50					
Culvers loam	8	30	20	1 25	[2] 1 25		1 50		6
Culvers silt loam	8	30	20	1.50	[2] 1 50		1.75		6
Culvers stony loam									
Culvers stony silt loam									
Dutchess silt loam	12	45	20	1 50	1.75	2 00		2.25	15
Holly silt loam									
Lackawanna silt loam	12	45	22	1 25	1.75	2 00		2 25	17
Shallow phase	9	30	15	1 00	1.50	1.75		2 00	15
Lackawanna stony silt loam									
Shallow phase									
Liberty sandy loam	10	40		1.00	1 50	1.75			
Liberty stony sandy loam									
Mansfield stony silt loam									

Nassau shale loam				.75					
Norwich silt loam									
Norwich stony silt loam									
Otisville gravelly loam									
Otisville gravelly sandy loam		15		.75	1 00				
With careful management [6]	9	30		1 25	1.50				
Peat									
Pittstown silt loam	10	30	17	1.25	[5] 1 50		1.75		
Pittstown stony silt loam									
Riverwash									
Rough mountainous land									
Rough stony land									
Smooth stony land (Catskill soil material)									
Troy gravelly loam	12	40	20	1 25	1 75	1 75		2 25	14
Tunkhannock gravelly loam	14	40	20	1 50	2 00	2 00		2 50	15
Alluvial-fan phase	10	35		1 25	1 50	1 50			
Tunkhannock loamy sand	9	30	18	1 00	1 25	1 50		1 75	
Wallkill silt loam									
Walton gravelly loam	14	45	25	1 50	2 25	2 25		2 25	18
Walton silt loam	16	50	25	2 00	2 50	2.25		2 50	18
Walton stony loam									
Walton stony silt loam									
Wellsboro silt loam	9	30	17	1 50	[5] 1 25		1 75		7
Wellsboro stony silt loam									
Wurtsboro sandy loam	8	30		1 00	[5] 1 25		1 50		
Wurtsboro stony sandy loam									

[1] Yields are essentially averages of those obtained from farmers during the progress of the soil survey, although some, especially for pasture, are very definitely estimates because of a lack of data, generally because of the small extent of the soil type or the infrequent growing of the crop. Absence of a yield estimate indicates that the crop is not commonly grown. Common current practices include (1) A 5-year rotation of corn, oats, and mixed hay for 3 years, (2) the use of 1 to 1½ tons of lime at time of seeding of oats, (3) the application of about 10 tons of manure prior to the planting of corn (some may be added also to hay in the second season), (4) the application of from 400 to 600 pounds of 16-percent superphosphate to cornland or the use of a similar amount within the rotation.

[2] The term "cow-acre-days" is used to express the carrying capacity or grazing value of pasture land. It represents the number of days that 1 animal unit can be supported on 1 acre without injury to the pasture, or the product of the number of animal units to the acre multiplied by the number of days of grazing. The animal unit is a means of measuring the feed requirements of livestock. It is the equivalent of a mature cow, steer, or horse, or 5 hogs, or 7 sheep or goats. 1 cow or 1 animal unit for 100 days of ... would rate 100 cow-acre-days, and a s... unit to 4 acres for 100 days would rate.

[3] Yields for specific vegetables on an ... small extent of any one kind of vegeta...

[4] General farming, as used here, re... corn, for the feeding of livestock, most...

[5] Alsike clover is also generally incl... imperfectly drained soils.

[6] Careful management on Otisville ... is practiced by some farmers in main... heavy applications of manure and c... manures.

TABLE 9.—*Productivity ratings of soils in Sullivan County, N.*

Soil [1]	Crop productivity index [2] for—										
	Corn (silage) (100= 12 tons)	Oats (100= 50 bu.)	Buckwheat (100= 25 bu.)	Timothy (100= 2 tons)	Mixed timothy and red clover (100= 2 tons)	Red clover (100= 2 tons)	Mixed timothy and alsike clover (100= 2 tons)	Mixed alfalfa and timothy (100= 3 tons)	Potatoes (100= 200 bu.)	Pasture (100= 100 cow-acre-days [3])	G nur
Barbour silt loam	130	100	----	100	125	125	----	85	----	140	
Walton silt loam	130	100	100	100	125	115	----	85	90	125	
Walton gravelly loam	115	90	100	75	115	115	----	75	90	120	
Barbour fine sandy loam	115	90	----	90	100	115	----	85	----	115	
Barbour fine sandy loam, high-bottom phase	115	90	----	90	100	115	----	85	----	115	
Barbour gravelly loam	115	80	----	90	100	100	----	75	----	125	
Lackawanna silt loam	100	90	90	60	90	100	----	75	85	105	
Tunkhannock gravelly loam	115	80	80	75	100	100	----	85	75	90	
Chenango gravelly loam	110	90	100	75	90	100	----	75	----	80	
Dutchess silt loam	100	90	80	75	90	100	----	75	75	105	
Troy gravelly loam	100	80	80	60	90	90	----	75	70	90	
Catskill silt loam	100	90	80	60	75	90	----	65	85	105	
Catskill loam	85	90	70	60	75	90	----	65	85	90	
Liberty sandy loam	85	80	----	50	75	90	----	----	----	70	
Barbour gravelly loam, alluvial-fan phase.	100	70	----	75	75	75	----	65	----	80	
Tunkhannock gravelly loam, alluvial-fan phase	85	70	----	60	75	75	----	----	----	80	
Wellsboro silt loam	75	60	65	75	60	----	90	----	35	80	
Pittstown silt loam	85	60	65	60	75	----	90	----	----	90	
Lackawanna silt loam, shallow phase.	75	60	60	50	75	90	----	65	75	80	
Chenango gravelly sandy loam	85	60	60	60	75	----	----	65	----	45	

Culvers silt loam	65	60	80	75	75		90		30	80
Otisville gravelly sandy loam (with careful management).[5]	75	60		60	75					70
Basher silt loam	75	60		50	75		90			70
Barbour loamy sand	65	50		50	75	75		60		50
Wurtsboro sandy loam	65	60		50	60		75			60
Culvers loam	65	60	80	60	60		75		30	60
Tunkhannock loamy sand	75	60	70	50	60	75		60		50
Braceville silt loam	65	60		50	75		90			60
Catskill sandy loam	65	50		35	60					40
Colchester gravelly loam		25		50	60					45
Otisville gravelly sandy loam		30		35	50					35
Alluvial soils, undifferentiated				50						80
Norwich silt loam				35						50
Colchester loamy sand				25						35
Nassau shale loam										50
Walton stony silt loam										55
Walton stony loam										55
Pittstown stony silt loam										50
Lackawanna stony silt loam										50
Wellsboro stony silt loam										50
Catskill stony silt loam										50
Lackawanna stony silt loam, shallow phase.										40
Culvers stony silt loam										35
Mansfield stony silt loam										35
Otisville gravelly loam										30
Catskill stony loam										30
Culvers stony loam										30
Liberty stony sandy loam										25
Wurtsboro stony sandy loam										25
Barbour loamy sand, gravel-sub stratum phase.										25
Catskill stony sandy loam										25
Norwich stony silt loam										20
Holly silt loam										20

See footnotes at end of table.

TABLE 9.—*Productivity ratings of soils in Sullivan County, N. Y.*—C

Soil [1]	Crop productivity index [2] for										
	Corn (silage) (100= 12 tons)	Oats (100= 50 bu.)	Buckwheat (100= 25 bu.)	Timothy (100= 2 tons)	Mixed timothy and red clover (100= 2 tons)	Red clover (100= 2 tons)	Mixed timothy and alsike clover (100= 2 tons)	Mixed alfalfa and timothy (100= 3 tons)	Potatoes (100= 200 bu.)	Pasture (100= 100 cow-acre-days [3])	Gr nur
Peat										20	
Wallkill silt loam										10	
Smooth stony land (Catskill soil material)										5	
Rough mountainous land											
Rough stony land											
Riverwash											

[1] The soils are listed in the approximate order of their general productivity under the prevailing practices of soil management, the most productive first. See footnote 1, table 8, for explanation of prevailing practices of soil management.

[2] The soils are given indexes that indicate the approximate average production of each crop in percentage of the standard of reference. The standard represents the approximate average acre yield obtained without the use of amendments on the more extensive and better soil types of those regions in the United States in which the crop is most widely grown. The indexes are based on estimates of yields (see table 8), as yield data are too fragmentary to be adequate. Absenc grown on the particular soil type.

[3] See footnote 2, table 8, for explana

[4] These numbers indicate the gener Refer to the text for further explanati

[5] This is a grouping of soils on the ba purposes of broad comparisons.

The principal factors affecting the productivity of land are climate, soil (including the many physical, chemical, and biological characteristics), slope, drainage, and management (including the use of amendments). No one of these factors operates separately from the others, although some one may dominate. In fact, the factors listed may be grouped simply as the soil factor and the management factor. Slope, drainage, and most of the aspects of climate may be considered as characteristics of a given soil type, since the soil type, as such, occupies specific geographical areas characterized by a given range of slope and climatic conditions. Crop yields over a long period of years furnish the best available summation of the associated factors and therefore are used where available.

General productivity grade numbers are assigned in the column "General productivity grade." This grade is based on a weighted average of the indexes for the various crops, the weighting depending upon the relative acreage and value of the crops. If the weighted average is between 90 and 100 the soil type is given a grade of 1; if it is between 80 and 90 a grade of 2 is given, and so on.[14] In Sullivan County no precise mathematical procedures were followed in establishing the general productivity grade. The grade numbers were assigned arbitrarily by visual inspection of the indexes, particularly those for corn silage, oats, and mixed timothy and red clover. As it is difficult to measure mathematically or otherwise either the exact significance of a crop in the agriculture of an area or the importance or suitability of certain soils for particular crops, perhaps too much significance may be given to the order in which the soils are listed. On the other hand, the arrangement does give information as to the general productivity. Descriptive terms of general productivity for groups of the soils are given in the column "General productivity group."

The right-hand column of table 9 gives a few statements as to the general characteristics and physical suitability for use of the soils of each group. A grouping of soils on the basis of general productivity will not necessarily coincide in all respects with a grouping on the basis of physical suitability for use, since other characteristics in addition to productivity influence the general desirability of soils in respect to their use for crops. For example, slight differences in productivity may be overshadowed by differences in workability or the maintenance of productivity and the prevention of erosion. The statements given here for each productivity group are applicable to the group as a whole, but it is to be remembered that the arrangement or order of listing of soils is based on general productivity.

Productivity tables do not present the relative roles that soil types, because of their extent and the pattern of their distribution, play in the agriculture of the county. The tables show the relative productivity of individual soils. They cannot picture in a given county the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types used for each of the specified crops.

Economic considerations play no part in determining the crop productivity indexes. These indexes cannot be interpreted, therefore, into land values except in a very general way. Distance to market,

[14] The grade number 1+ is used for soils with a weighted average between 100 and 110, and 1++ for soils with a weighted average between 110 and 120.

relative prices of farm products, and other factors influence the value of land. It is important to realize that productivity, as measured by yields, is not the only consideration that determines the relative worth of a soil for growing crops. The ease or difficulty of tillage and the ease or difficulty with which productivity is maintained are examples of considerations other than productivity that influence the general desirability of a soil for agricultural use. In turn, steepness of slope, presence or absence of stone, the resistance to tillage offered by the soil because of its consistence or structure, and the size and shape of areas are characteristic of soils that influence the relative ease with which they can be tilled. Likewise, inherent fertility and susceptibility to erosion are characteristics that influence the ease of maintaining soil productivity at a given level. Productivity, as measured by yields, is influenced to some degree by all these and other factors, such as moisture-holding capacity of the soil and its permeability to roots and water. Therefore, these factors are not to be considered entirely separately from productivity; on the other hand, schemes of land classification to designate the relative suitability of land for agricultural use must give some recognition to them.

GENERALIZED LAND-USE SUITABILITY MAP

Figure 2 shows the general distribution of the soils of Sullivan County according to their suitability for use as cropland, pasture land, and forest land. Although not greatly different, the areas on this map are not identical with those of the five grades of land shown in different colors on the detailed soil map. The small scale required a certain degree of geographical generalization. It will be noted that a slight difference exists also in the definitions of the Fourth-grade soils on the one map and pasture land on the other.

Figure 2 shows that the county is dominantly forest land, the principal areas of which are in the southern, southeastern, and northern parts and in a fringe along the western border. The areas of excellent cropland and of good and fair cropland are rather widely scattered and irregular in shape and size. It can also be observed that the areas of fair cropland and pasture land are the next most extensive after forest land, and that they are principally in the central and north-central parts of the county. Pasture land, as a separate category, is shown to be relatively inextensive.

LAND USES AND AGRICULTURAL METHODS

The agriculture of Sullivan County is developed in support of dairying and poultry raising. Farming is based on the sale of dairy and poultry products on the market and to some extent, on boarding houses. The farm income on many farms in the county is supplemented by income from summer boarders, and much of the poultry and dairy produce is used right on the farms. Although only 33 percent of the farms, according to the 1940 census, are classed as dairy farms and 19 percent as poultry farms, as determined by the source of 40 percent of the farm cash income, 78 percent of the farms kept dairy cows and 71 percent kept poultry.

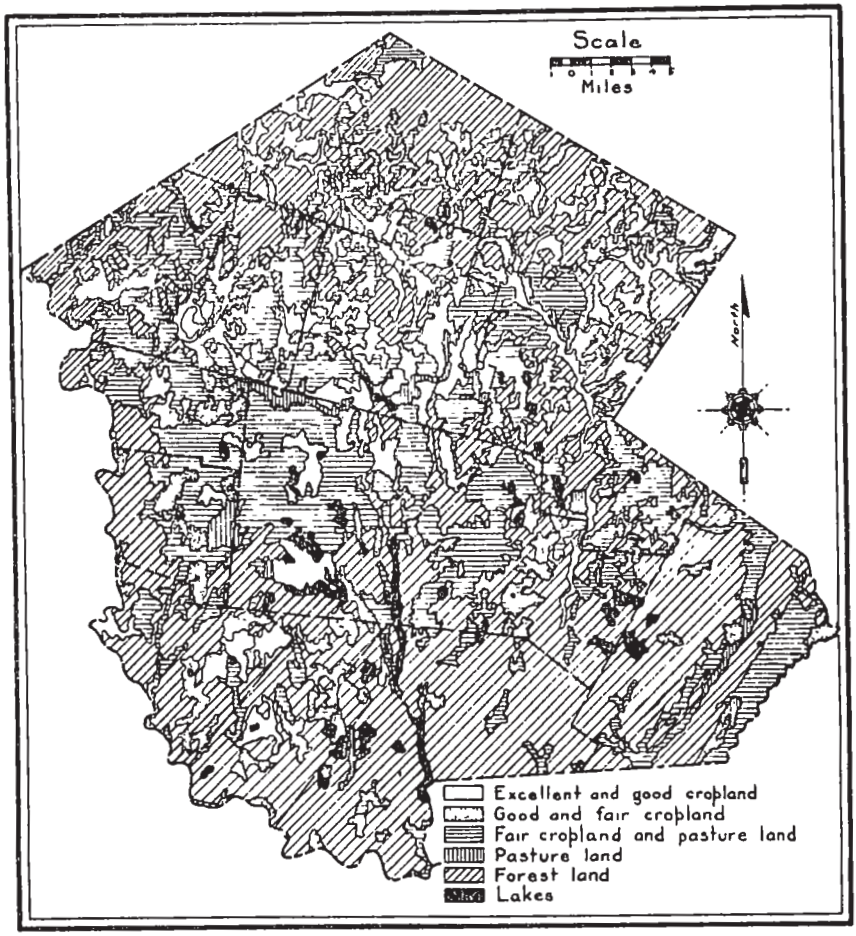

FIGURE 2.—Generalized land-use suitability map of Sullivan County, N. Y., (black areas are lakes).

On most farms the crop practices are such as to support the needs of dairy farming. On dairy farms generally sufficient roughage is grown for the dairy and work animals. Pasture for these animals is maintained, and sufficient silage is produced to carry the cows through the winter. Much of the proteins and concentrated feeds, however, for both dairy and poultry are purchased. This practice is made feasible by the cheapness of western grain and the fact that the fertility elements of this feed are utilized in the manure applied to the soil. The large quantity of manure produced makes possible the growing of crops supplemented with a small quantity of commercial fertilizers.

The crops commonly grown, the soil treatment, and the rotations followed under present conditions of agriculture have been discussed in previous paragraphs in the section on Agriculture. The need of limestone and superphosphate on the soils can hardly be overemphasized, as the soils are most deficient in these materials.

Studies on similar soil types in Delaware County (*5*) indicate a range in lime requirement for clover from little or none to as much as 2 tons an acre. The soils of the till uplands have a lime requirement ranging from 1 to 2 tons. Over 40 percent of the area of the Culvers and Lackawanna soils show a need of 1½ tons or more. On the average farm in Sullivan County lower applications of lime are made on these soils, and on many of the poorer farms no lime at all is applied.

There is every indication that the soils of the county are deficient in phosphorus. Although this is recognized and applications of phosphates are made with manure for corn, the recommended applications for the same soils in Delaware County are much higher than the 200 to 300 pounds an acre commonly applied on soils in Sullivan County. From 600 to 800 pounds of 16-percent superphosphate an acre, or its equivalent in higher analysis phosphates, is recommended for the Lackawanna, Culvers, Walton, and associated soils of the uplands. This quantity is recommended for a 4-year rotation, and if hay is to be continued a fifth and sixth year a top dressing of eight loads of manure and 30 to 50 pounds of superphosphate a load are recommended.

As previously stated, very little mammoth clover is grown in Sullivan County. It is commonly believed that this clover grows too rank and lodges on the better soils of the county or is too coarse and stemmy. For this reason it is not often used in seedings. Grown on many of the less fertile and porous soils, however, it usually yields as well as and often better than the other clover varieties. If grown on the lighter textured Catskill and Culvers soils and on the loamy sand soils of the terraces and first bottoms it would probably do better than the medium red or alsike clovers.

About 62 percent of the total area of Sullivan County is unsuited for cultivation and is for the most part in forest. Much of this land is too rough and rugged, too poorly drained, and too shallow or is otherwise unsuited to justify clearing for cultivation. That much of the present land under cultivation was very stony when first settled is without question. Evidence of the stones cleared from the land remains in the many stone fences surrounding the fields today. Of the remaining stony land, probably 10 percent would be suitable for cultivation if cleared of stone and trees. It occurs, however, mostly in scattered areas.

Agriculture has developed most extensively on the soils of the uplands developed from red shales and sandstones. These are the most productive of the soils of the uplands. About 75 percent of the uplands in farms represents the Lackawanna, Walton, and Wellsboro soils, which are developed mostly from red shale and sandstone materials. Only about 20 percent of the uplands in farms represents the Catskill, Liberty, and Culvers soils, which are developed mostly from gray sandstone materials. Approximately 5 percent of the uplands in farms represents the Wurtsboro, Dutchess, Troy, and Pittstown soils in the southeastern part of the county.

EROSION

Erosion is not a serious problem in this county, even though a large part of the land has a strong relief. A rather large part, especially

the rougher areas, is in forest, and soil wastage from forest land, however steep, is negligible. In this, a dairying section, grassland forms such a large proportion of the uplands that likelihood of injury by erosion is limited to a very small part of the total acreage of cropland and plowable pasture. According to the 1940 census about 5 percent of all the land in farms was cropland harvested or failure; 19 percent was in plowable pasture; 34 percent was in woodland, including woodland pasture; 21 percent was in hay, 19 percent in all other land, including other pasture, and 2 percent was idle or fallow. Of this very small percentage of land requiring tillage or precrop plowing, some represented smooth alluvial land and terraces, which are practically immune to injury by erosion.

Erosion on fall-plowed land and land allowed to remain fallow throughout the winter is active during heavy rains and at the time of spring thaws. Corn is usually followed by oats or mixed grain, and the land remains fallow during the winter. About half of the land prepared for corn and oats is plowed in fall; the rest is plowed in spring. The use of rye as a cover crop to prevent erosion is recommended. Most of the corn crop is used for silage, and this practice leaves ample time to sow rye. The main objection is that of additional labor being required for an extra plowing of the land. Unquestionably more time would be involved, but the curtailment of erosion and the addition of organic matter to the soil would likely be a good investment.

Much pasture land is by no means free from erosion, although in most places erosion of pastures is slight. There is a growing trend in the county toward better land use in respect to pasture improvement. In recent years the increased use of lime and phosphates has been made possible by the agricultural conservation program. This use of amendments on pastures provides a better protective cover and on some farms makes possible the retirement of areas of poorer pasture to forest.

About 2 percent of the farm land was idle, according to the 1940 census. Much of this idle land occurs where hotel interests have become greater and the farm land is no longer worked. Erosion on this land depends a great deal on the conditions of the land before it was allowed to remain idle. Reforestation of some of the idle land would seem advisable.

Cash rental of farms is often an inducement to exploitation of the land. Short-term rentals provide little incentive for practicing soil-conserving methods. This is not a serious matter in this county, however, as only 7 percent of the farms are operated by tenants, and most of the farms are operated by full owners.

At present the most active erosion is largely confined to the sloping land used for intertilled crops, such as corn and potatoes. The practice of planting corn and potatoes or other row crops in straight rows irrespective of the slope could be modified to conform more with the contour without causing great inconvenience in cultural operations. Sod or strip cropping, using alternate belts of sod and tilled crops, would in a large measure eliminate erosion on some farms. Strip cropping on many farms, however, is impossible because of the many stone fences surrounding the fields.

MORPHOLOGY AND GENESIS OF SOILS

Sullivan County embraces parts of the scenic Appalachian Plateaus in southeastern New York. It lies along the southerly slopes of that rugged area known as the Catskill Mountains. The plateau is dissected into ridges and deeply incised valleys. Elevations range from about 380 feet above sea level in the valleys to a maximum of 3,051 feet on the mountains.

The county lies in the glacial province of the United States, where the parent materials of the soils have been accumulated largely through glacial action and deposited as till or as outwash from the melting and receding glacier. Only a comparatively small area has been derived from recent stream deposits. The mantle of glacial till from which the soils have developed is comparatively shallow, much shallower on the uplands than in the lower lying valley lands. The outwash terraces and fans consist of coarse assorted materials. The recent alluvial soils are composed of finer materials deposited on the present flood plains of the streams.

The soils of the county are, for the most part, Brown Podzolic, Podzol, and Gray-Brown Podzolic soils (*S*). Podzolization has been much more active in some places than in others. The best Podzol development would naturally occur on the somewhat flattened ridge tops and on the lighter materials on the outwash terraces. Most of these areas are cleared. Where the land is under sod, and where the forests have been cut over in recent years, much of the evidence of Podzol profiles has been destroyed.

Originally this county was forested with dense stands of evergreens (hemlock, white pine, pitch pine, spruce, and balsam) and numerous deciduous trees (oaks, chestnut, beech, maples, birches, ash, hickory, elm, tuliptree, and others). The leaves falling from the trees furnished material for the organic layer, and the density of the stand shaded the surface of the soil, keeping it cool so that oxidation proceeded very slowly.

The soils of the county contain little calcareous material in the form of calcium carbonate. The climate is humid, as the annual rainfall varies from about 41 to 45 inches; and the temperature is comparatively cool, as the summers are short and the winters are cold. These environmental conditions have favored podzolization; that is, the leaching of iron, alumina, and humus from the surface horizons and the concentration of these materials in lower horizons. Those soils that can be classed as Podzols are only weak ones. Evidences of true Podzols are not uniform and in many places are not observable. The Wurtsboro and Liberty soils are weak Podzols.

Nearly all of the soil-forming or parent material consists of Devonian sandstones and shales of the coarse-grained pale-olive and gray sandstone and conglomerate of the Catskill formation and the somewhat finer grained red Oneonta sandstone and shale formations. These materials, under the mechanical glacial action and later weathering, have produced the larger part of the soils of the county. The small area in the southeastern part of the county differs in that the soil-forming materials are similarly derived from older rock formations of Shawangunk conglomerate (Silurian formations) and Hudson River shales (Ordovician formations). As these rock materials

are very largely siliceous, they contribute little or no calcareous or limy materials.

The red parent materials, those from the Oneonta formations, give rise to the red color that predominates in soils over most of the central and western parts of the county. The more distinctly reddish soils from the glacial till material of the uplands are identified as the Lackawanna, Walton, and Wellsboro soils. Reddish soils from water-laid materials are members of the Tunkhannock and Colchester series on the valley terraces and of the Barbour series on the recent flood plains. The gray or greenish-gray parent materials, those from the Catskill formations, give rise to the more grayish soils, which predominate at the higher elevations in the northern part of the county and in the eastern and southern parts. The more distinctly gray soils from glacial-till materials of the uplands are identified as members of the Catskill, Culvers, and Liberty series. The gray or olive-gray shale parent materials of the Hudson River shale formation give rise to the Nassau, Dutchess, Pittstown, and Mansfield soils; and the Shawangunk parent materials give rise to the Wurtsboro soils in the till uplands. The Chenango and Otisville soils are developed on valley terraces and kames composed of gray shale and sandstone fragments. The Basher and Holly soils from these materials occur on the flood plains.

The well-drained soils of the uplands are members of the Lackawanna, Walton, Catskill, and Liberty series. These are zonal soils of the group of Brown Podzolic soils. The Lackawanna and Walton soils in many places are incipient Podzols and have developed a thin gray leached layer over an illuvial dark-brown horizon, under forest conditions. In most places these soils do not have a developed gray horizon typical of Podzols, and beneath the brownish-gray A horizon the B horizon is brown or yellowish brown and heavier in texture than the surface soil.

The following is a description of Lackawanna stony silt loam. This area was covered with a layer of loose leaf litter and dark-brown raw humus about 2 inches thick. The location is about three-fourths of a mile west of Shandelee Lake southwest of Livingston Manor at an elevation of 1,840 feet.

A. 0 to 4 inches, dark reddish-gray friable stony silt loam well mixed with humus.

B_1. 4 to 13 inches, dark reddish-gray friable crumbly stony silt loam having no well-defined structure.

B_2. 13 to 22 inches, Indian-red (weak-red) firm to compact but friable heavy silt loam containing some small stones and gravel. It breaks into medium-hard irregular fragments.

C_1. 22 to 40 inches, weak-red to dusky-red very compact heavy silt loam or silty clay loam. The soil breaks into irregular hard fragments that are vesicular.

C_2. 40 to 55 inches, dusky-red very compact and dense heavy silt loam glacial till that chips into rather brittle irregular vesicular fragments. This rests on bedrock of red Oneonta shale.

Throughout the profile and on the surface the soil is more or less stony, and the several horizons are decidedly acid in reaction. Although the soil is compact, internal drainage is good.

Closely associated with the Lackawanna soils but at lower elevations—generally in valley-fill positions—are the Walton soils. The parent glacial till is deeper than that of the Lackawanna soils and

contains more foreign materials. The following is a description of a profile of Walton gravelly loam observed south of Aden in Neversink at an elevation of 1,700 feet. The surface was covered with a 1- to 2-inch forest-litter layer of leaves of beech, birch, and maple.

A_1. 0 to 2 inches, very dark gray to black finely granular gravelly loam.
A_2. 2 to 9 inches, reddish-gray friable gravelly loam having no well-defined structure.
B_1. 9 to 16 inches, light brownish-gray gravelly friable silt loam with a very small irregular fragmental structure.
B_2. 16 to 24 inches, reddish-gray slightly compact or firm gritty silt loam having a thin platy structure
B_3. 24 to 48 inches, weak-red compact gritty silt loam having an irregular fragmental structure.
C. 48 to 120 inches or more, weak red very compact gravelly silt loam having a vesicular large irregular fragmental structure.

Throughout the soil there are many rounded glacial boulders and angular red sandstone fragments of local origin. The reaction is moderately to strongly acid; and although the deep subsoil is compact, internal drainage is good.

The Wellsboro soils occupy the gentler slopes in association with the Lackawanna and Walton soils. These soils are intrazonal, are associated closely with the Brown Podzolic soils, and are imperfectly drained. They have a tendency to weak Planosol development.

The Tunkhannock and Colchester soils of the terraces and kames have developed profile characteristics of the Brown Podzolic soils. In a few areas Tunkhannock gravelly loam has developed a true Podzol profile. Tunkhannock loamy sand, as mapped in this area, would have been separated into another series had it been extensive, as it does not have a true Brown Podzolic soil development.

The Catskill soils may be considered as Podzol enclaves of the Brown Podzolic soils, especially the loam and sandy loam types. Incipient gray Podzol A_2 layers can be observed in many places in forested areas of these soils, but this development is not uniform. No evidence of a weak Podzol development was observed in Catskill silt loam.

The following is a description of a profile of Catskill stony loam observed southeast of Eldred at an elevation of approximately 1,340 feet. The surface was covered with a shallow layer of forest litter of leaves of oaks, maple, birch, and pitch pine.

A_1. 0 to 3 inches, dark brownish-gray loose friable gravelly loam having a fine-crumb structure.
A_2. 3 to 8 inches, brownish-gray loose friable gravelly loam.
B_2. 8 to 15 inches, dusky-brown mellow and structureless heavy loam or light silt loam.
B_3. 15 to 26 inches, yellowish-brown firm but friable gritty loam showing a weak irregular small fragmental structure.
C. 26 to 42 inches, light-gray or light olive-gray compact sandy loam showing an irregular small fragmental to platy structure. This rests on light olive-gray bedrock.

Angular stones and small boulders of the local sandstone rocks are numerous throughout the soil and on the surface. The reaction is strongly or very strongly acid in all horizons.

The Liberty soils, which are closely associated with the Catskill soils, are weak Podzols, and in a few undisturbed forested areas of these soils a thin gray A_2 horizon occurs. As the series is not ex-

tensive, there is some question as to whether this series might not better be included as an enclave of the Brown Podzolic soils.

The Culvers soils are intrazonal and closely associated with the Brown Podzolic Catskill soils. They are imperfectly drained, occupy the gentler slopes, and have a weak Planosol development. The influence of the local red Oneonta shales and sandstones is reflected in the light reddish or pinkish cast common in these soils.

The Norwich soils and peat are hydromorphic soils and are well distributed throughout the plateau area of the county. They have developed in wet situations where percolation is slight and where the areas are always moist or even inundated.

The Chenango soils, which occur in the valleys of Basher Kill and Shawangunk Kill, are well to excessively drained and are acid throughout. In these soils, development of a distinct profile is not everywhere complete and the geologic characteristics are still apparent in the profiles. The profile of the Chenango soils approaches the profile typical of the Brown Podzolic soils.

The Wurtsboro soils in the Shawangunk Mountains are weak Podzol soils and have a thin ash-gray A_2 horizon development in most undisturbed forested areas. The surface horizons are light-textured, ranging from sandy loam to loam, and the subsoil horizons are somewhat heavier textured. The following description of Wurtsboro stony sandy loam was taken south of Wurtsboro on the northwest slope of the Shawangunk Mountains at an elevation of about 800 feet. The forest litter over the soil ranges in thickness from 1 to 3 inches, and is composed mostly of oak leaves mixed with some pine, maple, ash, tuliptree, and sassafras leaves.

1. 0 to 1 inch, fine black crumb mull.
2. 2 to 5 inches, light-gray or ash-gray structureless very porous stony sandy loam.
3. 5 to 12 inches, dark yellowish-brown to dusky-brown fragmental gravelly loam.
4. 12 to 19 inches, yellowish-brown firm to slightly compact lumpy gritty silt loam slightly stained with yellow and dusky brown.
5. 19 to 24 inches, pale-brown compact platy gritty silt loam strongly marbled with yellow, light gray, and dusky brown.
6. 24 to 32 inches, dark-brown very compact hard gritty silt loam. A light-gray coating stained with yellow follows the breakage planes or cracks.
7. 32 to 180 inches or more, dark-brown very compact hard gritty silt loam or glacial till having a rather cloddy structure.

Many boulders and stones occur throughout the soil. The soil materials are derived from about 80 percent of Shawangunk quartzite conglomerate materials and 20 percent of coarse sandstones of the Catskill formation and finer Hudson shales. The various horizons are decidedly acid.

The soils on the southeastern slopes of the Shawangunk Mountains have developed under less humid conditions than in the other areas of the county. In this small area of the county conditions are less favorable for true Podzol development, the winters are somewhat milder and not so long, summer temperatures are higher, and the forests are mostly deciduous. The profile development is more like that of the Gray-Brown Podzolic soils.

The Dutchess, Pittstown, and Troy soils are the principal Gray-Brown Podzolic soils. These soils are not extensive. The Dutchess

and Troy are both well drained, and the Pittstown is imperfectly drained. The Dutchess and Pittstown soils are developed principally from Hudson slates and shales and are medium acid throughout. The Troy soil is developed from a mixture of sandstones and shales and has sufficient calcareous sandstone material in the subsoil to make the deep subsoil slightly alkaline. These soils contain a certain mixture of Shawangunk conglomerate materials, owing to their proximity to this conglomerate formation.

Closely associated with these soils is the Mansfield soil, which is a poorly drained soil of the depressions and gently sloping areas at the heads of streams. These are hydromorphic Half Bog soils associated with the Gray-Brown Podzolic soils.

The Nassau soil is a shallow soil or Lithosol closely associated with the Dutchess soil. It has very little development and is composed mostly of Hudson slates and shales. Rough stony land and rough mountainous land represent Lithosols closely associated with the Catskill and Lackawanna soils. The underlying rock formations include Oneonta shales in the western and northern parts of the county, Catskill sandstones in the eastern and southern parts, and Shawangunk conglomerate on the Shawangunk Mountains. Smooth stony land (Catskill soil material) represents Lithosols developed entirely from Catskill sandstone.

The recent alluvial soils are azonal, having little or no development. The high-bottom phases show more development than those of the first bottoms, having an incipient B horizon in the upper part of the subsoil but definite stratification in the lower part. The Barbour soils are the well-drained and the most important soils of the first bottoms. The Basher soil is imperfectly drained, and the Holly and Wallkill soils are permanently wet.

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SOIL MAP
SULLIVAN COUNTY
NEW YORK

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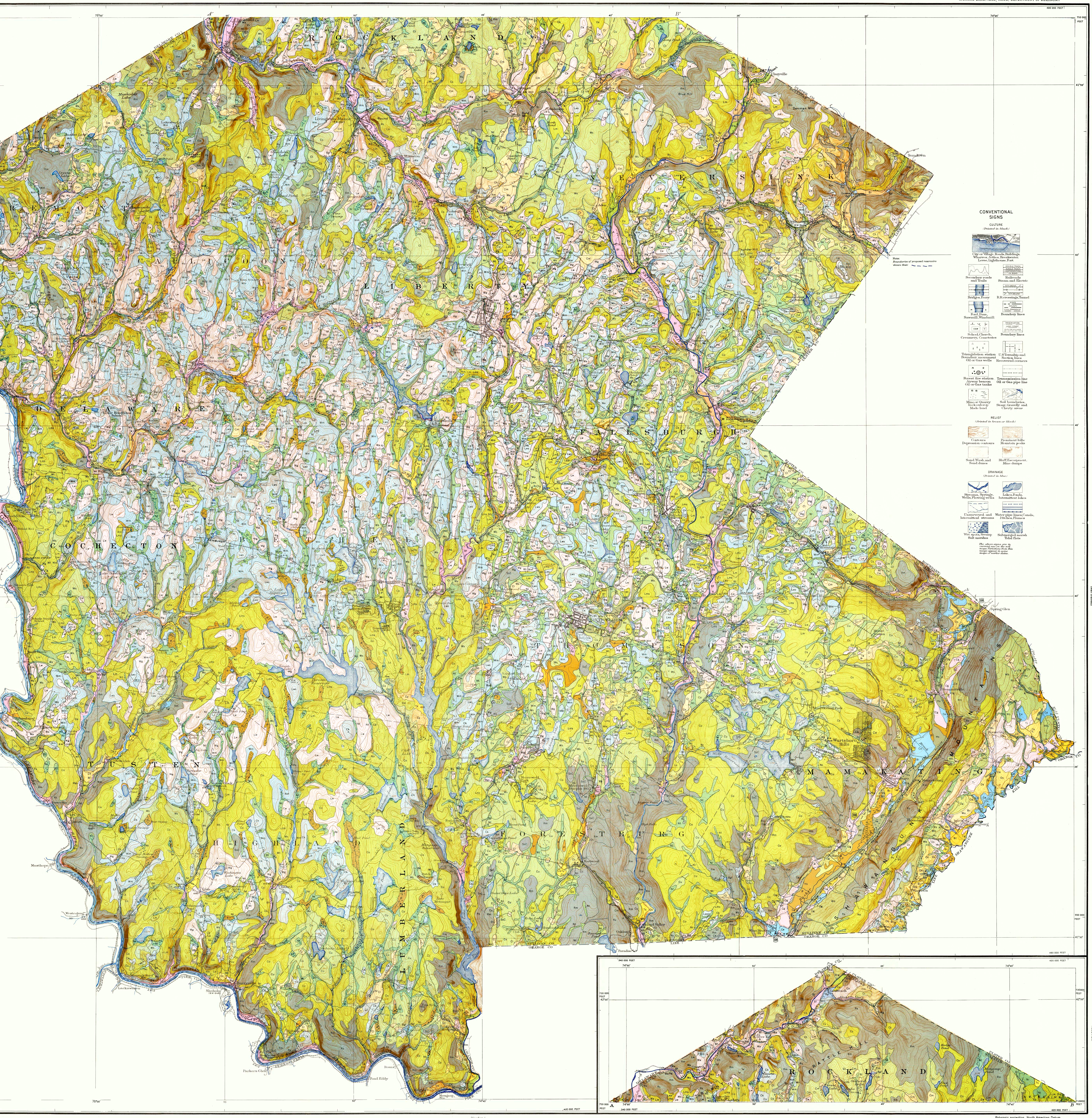
C. E. LADD, DIRECTOR
RICHARD BRADFIELD, HEAD, DEPARTMENT OF AGRONOMY



LEGEND

FIRST - GRADE SOILS (Good to excellent cropland)

BOTTOM LANDS (Well drained)
- Bf — Barbour fine sandy loam
- Bfb — High-bottom phase
- Bg — Barbour gravelly loam
- Bs — Barbour silt loam

TERRACES (Well drained)
- Cg — Chenango gravelly loam
- Tg — Tunkhannock gravelly loam

UPLANDS (Well drained)
- Ca — Catskill silt loam
- Ds — Dutchess silt loam
- Lw — Lackawanna silt loam
- Tr — Troy gravelly loam
- Wg — Walton gravelly loam
- Wa — Walton silt loam

SECOND - GRADE SOILS (Fair to good cropland)

BOTTOM LANDS (Well drained)
- Bgf — Barbour gravelly loam, Alluvial-fan phase

TERRACES (Well drained)
- Ce — Chenango gravelly sandy loam
- Tgf — Tunkhannock gravelly loam, Alluvial-fan phase

UPLANDS (Well drained)
- Ck — Catskill loam
- Lws — Lackawanna silt loam, Shallow phase
- Ll — Liberty sandy loam

UPLANDS (Imperfectly drained)
- Ps — Pittstown silt loam
- Wm — Wellsboro silt loam

THIRD - GRADE SOILS (Fair to poor cropland or pasture land)

BOTTOM LANDS (Well drained)
- Br — Barbour loamy sand

BOTTOM LANDS (Imperfectly drained)
- Bl — Basher silt loam

TERRACES (Well drained)
- Ts — Tunkhannock loamy sand

TERRACES (Imperfectly drained)
- Bc — Braceville silt loam

UPLANDS (Excessively drained kames)
- Ch — Colchester gravelly loam
- Os — Otisville gravelly sandy loam

UPLANDS (Well drained)
- Cy — Catskill sandy loam

UPLANDS (Imperfectly drained)
- Cm — Culvers silt loam
- Cl — Culvers loam
- Wu — Wurtsboro sandy loam

FOURTH - GRADE SOILS (Pasture, hay, and forest land)

BOTTOM LANDS (Well drained)
- Brg — Barbour loamy sand, Gravel-substratum phase

BOTTOM LANDS (Poorly drained)
- Hs — Holly silt loam
- A — Alluvial soils *(Undifferentiated)*

UPLANDS (Excessively drained kames)
- Cc — Colchester loamy sand
- Og — Otisville gravelly loam

UPLANDS (Well drained)
- Cd — Catskill stony sandy loam
- Co — Catskill stony loam
- Cs — Catskill stony silt loam
- Lm — Lackawanna stony silt loam
- Lms — Shallow phase
- Ls — Liberty stony sandy loam
- Ns — Nassau shale loam
- Wt — Walton stony loam
- Wy — Walton stony silt loam

UPLANDS (Imperfectly drained)
- Cu — Culvers stony loam
- Ct — Culvers stony silt loam
- Pl — Pittstown stony silt loam
- Ws — Wellsboro stony silt loam
- Wb — Wurtsboro stony sandy loam

UPLANDS (Poorly drained)
- Ms — Mansfield stony silt loam
- Nt — Norwich stony silt loam
- Nl — Norwich silt loam

FIFTH - GRADE SOILS (Forest and idle land)

ORGANIC DEPOSITS *
- P — Peat
- Wl — Wallkill silt loam

RECENT ALLUVIUM
- Rv — Riverwash

Stony or rough
- Rs — Rough stony land
- Rm — Rough mountainous land
- SsC — Smooth stony land (Catskill soil material)

* With artificial drainage some of the areas of organic deposits may become productive of special crops.

Polyconic projection, North American Datum.
Base map in part from U. S. Geological Survey Sheets.
10,000 foot grid based upon New York (East) system of plane coordinates.
Surveyed in 1936-38. Series 1938